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Downslope Conversion Experiment: Environmental Data Report

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DOWNSLOPE CONVERSION EXPERIMENT: ENVIRONMENTAL DATA REPORT

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ABSTRACT

This report presents the data collected during the Downslope Conversion Experiment (R/V New Horizon July 1-14, 1989). It also presents some of the data collected by other sources before and during the experiment. The data include plots of sound speed profiles from CTD stations (R/V New Horizon and USNS Narragansett) and XBT launches (R/V New Horizon and R/P Flip); temperature profiles from AXBT (P-3 flights); HLF-3 (sound source) depth time series; and wind time series. Also included here are satellite infrared images of the area under study.

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I. INTRODUCTION

The sound transmission part of the Downslope Conversion Experiment (DSCE) was conducted during the first two weeks of July 1989 in the area off Northern California, between Pt. Buchon and Pt. Arguello. The proposed track lines for the R/V New Horizon were designed so that the ship would sail across the continental shelf and slope in at least four and may be five lines, while towing the sound source (Figure 1). The actual cruise track is shown in Figure 2. The complete experiment involved pre-modeling of signal propagation, gathering of detailed information about the bathymetry and sub-bottom structure, measurement of environmental properties affecting the propagation medium, propagation of an acoustic signal at determined frequencies and locations, and the measurement of propagated signals at receiving sites.

The goal of the DSCE was to make carefully controlled and well-documented measurements of downslope signal propagation. These measurements were to provide information to study the physics of downslope propagation, proposed as one mechanism by which acoustic energy from surface sources gets coupled into the sound channel. More extensive and detailed information on the objectives of this experiment may be found in Hodgkiss et al [1].

This report presents the environmental information gathered aboard the R/V New Horizon, as well as some additional environmental information acquired before and during the cruise by other sources.

Not included in this report, but available, are ship sightings and wave hindcasting information provided by Fleet Numerical Oceanography Center. These data includes commercial ship positions as a function of time within a 500 km radius of 35 N - 122.5 W. It also includes ocean wave hindcasts at the spherical grid point corresponding to this location, the four points immediately sorrounding this site, and at the points 40 N - 122.5 W, 37.5 N - 125 W, 32.5 N - 125 W, 30 N - 122.5 W, and 34 N - 140 W.

II. R/V NEW HORIZON CRUISE DATA

a) CTD Stations

A total of 10 CTD stations were carried out during the cruise by personnel from the Physical and Chemical Oceanographic Data Facility (PACODF) of the Scripps Institution of Oceanography (Figure 3). A Neil Brown CTD with 4 Niskin bottles, to calibrate the temperature and conductivity sensors, was used for all stations. Instrument post-calibration, as well as raw data processing were done at PACODF. The sampling frequency was not pre-determined; rather, CTD stations were carried out upon time availability during ship stops for sound transmission stations. CTD stations were intermixed with XBT casts to keep at least one sample of the water column thermal structure every 4 hours.

All CTD stations sampled from surface to bottom. In most cases, these stations were located on the shelf/slope area. One station, station 8, was performed in deep water in order to obtain at least one complete sound speed profile for the entire water column off the continental shelf. Plots of sound speed profiles from CTD stations are included (Figure 4). The temperature and salinity profiles of this station were compared with the National Oceanographic Data Center average temperature and salinity profiles for the months July through September (Figures 5a, 5b). The similarity of these profiles allowed us to use the salinity from station 8, in conjunction with temperature profiles from the XBT casts, to calculate sound speed within a reasonable accuracy. These calculations are discussed in Appendix A.

TABLE 1: CTD from R/V New Horizon [6] (Times are GMT)

Date	Julian Day	Time	Event	Latitude	Longitude
07/03/89	184	10:08	CTD#01	34 57.7N	121 24.0W
07/04/89	185	21:47	CTD#02	35 07.2N	121 30.7W
07/05/89	186	16:32	CTD#03	35 07.4N	121 40.0W
07/06/89	187	02:10	CTD#04	35 07.1N	121 46.5W
07/06/89	187	14:15	CTD#05	34 53.1N	121 47.8W
07/07/89	188	01:50	CTD#06	34 54.0N	121 35.1W
07/07/89	188	13:00	CTD#07	34 36.0N	120 56.1W
07/11/89	192	10:05	CTD#08	34 50.6N	122 21.4W
07/11/89	192	18:00	CTD#09	34 55.4N	121 55.6W
07/13/89	194	11:35	CTD#10	35 08.2N	121 26.9W

b) XBT Profiles

A total of 61 XBT probes were launched during the DSCE cruise (Figure 6). The Sippican T-7 models reached a maximum depth of 700 meters, whereas the T-5 models reached 1800 meters. Launches number 37, 59, and 61 yielded incomplete data due to the probe conducting cable tangling with the HLF-3 cable. Launches were intended to maintain a 3 to 4 hour separation. Sound speed was calculated using XBT temperature and station 8 salinity data, as explained above (Figure 7). Collection of the data was done on an IBM-compatible computer with Sippican provided software. The data processing and graphics were done on a SUN computer at MPL with in-house developed software.

TABLE 2: XBT from R/V New Horizon [6] (Times are GMT)

Date	Julian Day	Time	Event	Latitude	Longitude
07/02/89	183	23:25	XBT#01	34 14.0N	119 55.5W
07/03/89	184	10:52	XBT#02	34 51.0N	121 45.0W
07/04/89	185	03:14	XBT#03	34 57.5N	121 26.9W
07/04/89	185	06:45	XBT#04	35 01.6N	121 26.4W
07/04/89	185	10:15	XBT#05	35 03.4N	121 25.4W
07/04/89	185	13:05	XBT#06	35 05.7N	121 26.2W
07/04/89	185	15:57	XBT#07	35 05.8N	121 27.1W
07/05/89	186	02:35	XBT#08	35 09.4N	121 29.3W
07/05/89	186	07:10	XBT#09	35 08.1N	121 32.8W
07/05/89	186	11:15	XBT#10	35 07.7N	121 35.2W
07/05/89	186	14:15	XBT#11	35 07.6N	121 38.5W
07/05/89	186	20:17	XBT#12	35 09.0N	121 42.2W
07/06/89	187	06:45	XBT#13	35 08.7N	121 47.6W
07/06/89	187	10:05	XBT#14	35 06.8N	121 52.0W
07/06/89	187	11:20	XBT#15	35 00.2N	121 50.1W
07/06/89	187	17:59	XBT#16	34 52.8N	121 42.0W
07/06/89	187	21:44	XBT#17	34 52.9N	121 38.1W
07/06/89	187	22:26	XBT#18	34 52.9N	121 38.0W
07/07/89	188	06:15	XBT#19	34 54.0N	121 30.0W
07/07/89	188	08:50	XBT#20	34 54.6N	121 27.8W
07/07/89	188	16:25	XBT#21	34 37.4N	120 56.8W
07/07/89	188	19:37	XBT#22	34 38.1N	121 06.8W
07/07/89	188	22:29	XBT#23	34 39.6N	121 17.8W
07/08/89	189	02:25	XBT#24	34 39.2N	121 20.1W
07/08/89	189	07:45	XBT#25	34 34.1N	121 25.1W
07/08/89	189	11:00	XBT#26	34 32.8N	121 37.4W
07/08/89	189	14:58	XBT#27	34 35.2N	121 45.8W
07/08/89	189	17:55	XBT#28	34 40.5N	121 57.5W
07/08/89	189	21:13	XBT#29	34 48.4N	122 20.3W
07/09/89	190	00:35	XBT#30	34 51.4N	122 20.4W
07/09/89	190	03:58	XBT#31	34 49.5N	122 18.3W
07/09/89	190	07:45	XBT#32	34 46.3N	121 56.2W
07/09/89	190	10:15	XBT#33	34 51.4N	121 55.4W
07/09/89	190	13:30	XBT#34	34 53.1N	121 50.2W
07/09/89	190	16:40	XBT#35	34 58.1N	121 58.5W
07/09/89	190	19:40	XBT#36	34 55.6N	122 06.7W
07/09/89	190	22:20	XBT#37	34 49.2N	122 22.5W
07/10/89	191	01:55	XBT#38	34 55.1N	122 22.9W
07/10/89	191	04:55	XBT#39	34 49.0N	122 21.5W
07/10/89	191	07:40	XBT#40	34 50.6N	122 20.4W
07/10/89	191	10:20	XBT#41	34 50.4N	122 20.9W
07/10/89	191	15:10	XBT#42	34 50.8N	122 22.1W
07/10/89	191	18:40	XBT#43	34 49.3N	122 21.3W
07/10/89	191	22:32	XBT#44	34 51.2N	122 21.0W
07/11/89	192	02:15	XBT#45	34 50.8N	122 20.8W
07/11/89	192	05:00	XBT#46	34 47.0N	122 19.3W
07/11/89	192	09:03	XBT#47	34 50.7N	122 22.9W
07/11/89	192	14:55	XBT#48	34 54.0N	121 54.6W
07/11/89	192	22:42	XBT#49	34 53.1N	121 48.1W
07/12/89	193	01:40	XBT#50	34 55.7N	121 48.7W

07/12/89	193	04:45	XBT#51	34 53.0N	121 39.8W
07/12/89	193	07:35	XBT#52	34 52.6N	121 41.1W
07/12/89	193	09:40	XBT#53	34 52.8N	121 38.6W
07/12/89	193	12:53	XBT#54	34 52.8N	121 34.7W
07/12/89	193	16:02	XBT#55	34 56.2N	121 35.5W
07/12/89	193	20:20	XBT#56	34 54.0N	121 30.0W
07/12/89	193	22:00	XBT#57	34 53.4N	121 28.1W
07/13/89	194	01:09	XBT#58	34 54.8N	121 28.7W
07/13/89	194	04:00	XBT#59	34 53.9N	121 22.6W
07/13/89	194	07:02	XBT#60	35 00.2N	121 24.8W
07/13/89	194	09:35	XBT#61	35 07.3N	121 26.8W

c) Depth of HLF3

One of the acoustic sources used during this experiment was a HLF-3, owned by NUSC and operated by Hydroacoustics. This instrument has a maximum operating depth of approximately 200 meters and a maximum towing speed of approximately 6 knots. The HLF-3 includes a pressure sensor that allows its depth to be monitored by operating personnel on board. In addition to this pressure sensor, a Recording Inclinometer Model 7011U from General Oceanics was attached to the HLF-3 to record Direction, Tilt Angle and Pressure at 1 minute intervals. We present here the Depth time series, as calculated from pressure, for the periods at which the HLF-3 was in the water (Figures 8a, 8b, 8c, and 8d). The following text is a list of events extracted from the DSCE Log Book [6]. Refer to this book for more detailed information. The numbers refer to the call numbers in the figures. All times are PDT; add 7 hours to convert to GMT.

From Figure 8a:

1- 7/3/89. Location: 34 53.65N, 121 40.47W.
2- 7/3/89 - 07:22. HLF-3 depth (from HLF-3 console) is 310 feet (or 95 meters). Transmitting 80 Hz. Going towards Point A.
3- On station. Sheave problem.
4- 7/3/89 - 12:00. Sheave fixed. Back underway.
5- 7/3/89 - 13:00 to 13:56. TR1.
6- 7/3/89 - 13:57 to 14:27
7- CTD #1, then DS1 and TR1.
8- 7/3/89 - 20:54 to 21:26. DS3 and TR5.
9- DS1 and TR1.
10- 7/4/89 - 01:00 to 01:14. DS3 and TR5
11- DS1 and TR1.
12- 7/4/89 - 04:30 to 04:53. TR4 and TR5
13- DS1, TR1, and TR2 (using HLF-3 for it).
14- (a) through (g): TR3 using HLF-3 for it.

From Figure 8b:

15- Heading 290 T (NW)
16- 7/7/89 - 17:35. Ship turning around to 218 T. At 18:13 she turned to 122 T. Downwind increased ship's speed.
17- 7/7/89 - 21:26. Turned back into the wind (265 T). Slowed down. On transit.

From Figure 8c:

18- 7/10/89 - 12:13 to 12:19 HLF-3 up to 83 meters. 12:30 -> DS2 for the second time (at 102 meters).
19- 7/10/89 - 18:56 to 19:13. Maneuvering to recover HLF-3.

From Figure 8d:

20- Started Line D-A. TR4.
21- Ship speed down to 5 knots. DS3 and TR5.
22- DS1. TR2, TR3, and TR4.
23- 7/11/89 - 19:34 to 21:52. DS3 and TR5.
24- Start DS1 at 21:52. Then TR1 and TR4.
25- DS3 and TR5.
26- DS3 and TR5.
27- DS2.
28- DS3 and TR5.
29- DS2.
30- DS3 and TR5
31- DS1, TR1, TR2, and TR3.
32- TR4, DS3, and TR5.
33- DS2.
34- In transit to DA8 with DS3 and TR5.
35- DS2.
36- In transit to station DA9 with DS3 and TR5
37- DS2.
38- DS3 and TR5.
39- DS1, TR1, TR2, TR3, and TR4.
40- DS3 and TR5.
41- DS1, TR1, TR2, TR3, and TR4.
42- DS3 and TR5.
43- DS1, TR2, and TR3.
44- CTD#10 and TR4.

III. P-3 AXBT DATA

This section includes the temperature profiles obtained with AXBT (aerial XBT probes from Sippican) (Figure 9a, 9b, and 9c). Three lines were made: the first line was made on 5 July (AXBT# 1001 to 1056, total of 56 AXBTs); the second line was made on 8 July (AXBT# 1601 to 1658, total of 58 AXBTs); and the third line on 10 July (AXBT# 1901 to 1958, total of 58 AXBTs). Vertical temperature sections (Figures 10a, 10b, and 10c), and "waterfall" plots (Figures 11a, 11b, 11c, 12a, 12b, 12c, 13a, 13b, and 13c) for each line are included to show the overall thermal structure of the water column during this experiment.

TABLE 3: P-3 AXBT Launches (Times are GMT)

AXBT#	Date	Julian Day	Time	Latitude	Longitude
1001	7/05/89	186	23:02:16	34 02.20N	139 20.40W
1002	7/05/89	186	23:07:16	34 05.30N	139 01.60W
1003	7/05/89	186	23:17:16	34 10.90N	138 22.80W
1004	7/05/89	186	23:27:16	34 15.90N	137 42.90W
1005	7/05/89	186	23:32:16	34 18.20N	137 24.00W
1006	7/05/89	186	23:37:17	34 20.80N	137 03.60W
1007	7/05/89	186	23:42:16	34 23.20N	136 45.50W
1008	7/05/89	186	23:52:16	34 10.33N	136 48.28W
1009	7/05/89	186	23:57:04	34 11.68N	136 31.63W
1010	7/06/89	187	00:01:40	34 11.02N	136 12.18W
1011	7/06/89	187	00:06:36	34 11.33N	135 53.60W
1012	7/06/89	187	00:11:30	34 11.62N	135 31.92W
1013	7/06/89	187	00:16:29	34 12.05N	135 16.32W
1014	7/06/89	187	00:21:28	34 12.92N	134 57.03W
1015	7/06/89	187	00:26:25	34 13.88N	134 37.75W
1016	7/06/89	187	00:31:17	34 14.92N	134 18.72W
1017	7/06/89	187	00:36:08	34 16.05N	133 59.48W
1018	7/06/89	187	00:41:14	34 17.18N	133 40.07W
1019	7/06/89	187	00:46:27	34 18.45N	133 20.85W
1020	7/06/89	187	00:51:27	34 19.65N	133 01.58W
1021	7/06/89	187	00:56:39	34 20.50N	132 41.12W
1022	7/06/89	187	01:02:13	34 21.58N	132 22.65W
1023	7/06/89	187	01:07:07	34 22.82N	132 03.12W
1024	7/06/89	187	01:12:00	34 23.78N	131 43.67W
1025	7/06/89	187	01:17:03	34 24.88N	131 22.83W
1026	7/06/89	187	01:21:58	34 26.10N	131 04.77W
1027	7/06/89	187	01:26:59	34 27.12N	130 45.55W
1028	7/06/89	187	01:32:03	34 28.30N	130 26.22W
1029	7/06/89	187	01:37:15	34 29.42N	130 07.08W
1030	7/06/89	187	01:43:04	34 29.80N	129 45.53W
1031	7/06/89	187	01:47:57	34 30.83N	129 27.02W
1032	7/06/89	187	01:58:34	34 33.22N	128 48.10W
1033	7/06/89	187	02:03:21	34 34.28N	128 29.33W
1034	7/06/89	187	02:08:43	34 35.43N	128 10.53W
1035	7/06/89	187	02:14:06	34 36.28N	127 50.70W
1036	7/06/89	187	02:19:24	34 37.38N	127 31.25W
1037	7/06/89	187	02:24:53	34 38.38N	127 11.63W
1038	7/06/89	187	02:30:27	34 39.55N	126 51.35W
1039	7/06/89	187	02:35:20	34 40.52N	126 31.48W
1040	7/06/89	187	02:43:03	34 41.13N	126 13.78W

1041	7/06/89	187	02:47:44	34 41.65N	125 55.33W
1042	7/06/89	187	02:52:24	34 42.42N	125 37.25W
1043	7/06/89	187	02:57:21	34 43.10N	125 18.05W
1044	7/06/89	187	03:02:05	34 44.57N	124 58.93W
1045	7/06/89	187	03:07:44	34 44.78N	124 30.62W
1046	7/06/89	187	03:12:36	34 46.02N	124 17.67W
1047	7/06/89	187	03:17:27	34 47.17N	123 58.37W
1048	7/06/89	187	03:22:22	34 48.43N	123 39.07W
1049	7/06/89	187	03:46:36	34 49.20N	123 19.27W
1050	7/06/89	187	03:51:32	34 50.97N	122 53.98W
1051	7/06/89	187	03:56:29	34 51.78N	122 39.90W
1052	7/06/89	187	04:01:25	34 52.78N	122 20.43W
1053	7/06/89	187	04:06:12	34 53.73N	122 01.05W
1054	7/06/89	187	04:10:53	34 54.88N	121 41.65W
1055	7/06/89	187	04:15:37	34 55.77N	121 22.03W
1056	7/06/89	187	04:20:00	34 55.27N	121 03.48W
1601	7/08/89	189	19:10:31	34 01.50N	139 38.30W
1602	7/08/89	189	19:15:04	34 02.60N	139 18.50W
1603	7/08/89	189	19:19:47	34 03.80N	138 59.50W
1604	7/08/89	189	19:24:25	34 04.90N	138 41.00W
1605	7/08/89	189	19:28:59	34 05.90N	138 21.60W
1606	7/08/89	189	19:32:39	34 07.20N	138 01.90W
1607	7/08/89	189	19:38:12	34 08.30N	137 42.30W
1608	7/08/89	189	19:42:50	34 09.40N	137 23.90W
1609	7/08/89	189	19:47:38	34 10.50N	137 04.10W
1610	7/08/89	189	19:52:13	34 11.70N	136 44.50W
1611	7/08/89	189	19:56:48	34 12.70N	136 26.00W
1612	7/08/89	189	20:01:24	34 13.90N	136 06.30W
1613	7/08/89	189	20:06:02	34 14.90N	135 46.80W
1614	7/08/89	189	20:10:43	34 16.10N	135 28.00W
1615	7/08/89	189	20:15:18	34 17.20N	135 09.10W
1616	7/08/89	189	20:19:56	34 18.30N	134 49.40W
1617	7/08/89	189	20:24:27	34 18.90N	134 30.50W
1618	7/08/89	189	20:29:03	34 20.10N	134 10.70W
1619	7/08/89	189	20:33:37	34 21.10N	133 51.70W
1620	7/08/89	189	20:38:09	34 22.20N	133 33.00W
1621	7/08/89	189	20:42:57	34 23.50N	133 13.00W
1622	7/08/89	189	20:47:38	34 24.50N	132 53.70W
1623	7/08/89	189	20:52:23	34 25.60N	132 34.[illegible]0W
1624	7/08/89	189	20:57:07	34 26.70N	132 15.40W
1625	7/08/89	189	21:01:55	34 27.80N	131 58.20W
1626	7/08/89	189	21:06:38	34 30.00N	131 38.00W
1627	7/08/89	189	21:11:20	34 30.10N	131 18.00W
1628	7/08/89	189	21:16:02	34 31.30N	130 57.20W
1629	7/08/89	189	21:20:37	34 32.20N	130 38.00W
1630	7/08/89	189	21:28:19	34 33.50N	130 19.00W
1631	7/08/89	189	21:32:49	34 34.50N	130 00.60W
1632	7/08/89	189	21:37:24	34 35.60N	129 41.30W
1633	7/08/89	189	21:42:04	34 36.60N	129 21.80W
1634	7/08/89	189	21:46:44	34 37.60N	129 02.60W
1635	7/08/89	189	21:51:35	34 38.80N	128 43.20W
1636	7/08/89	189	21:56:22	34 39.80N	128 23.50W
1637	7/08/89	189	22:01:14	34 41.10N	128 02.80W
1638	7/08/89	189	22:06:06	34 42.10N	127 45.10W

1639	7/08/89	189	22:10:52	34 43.20N	127 24.80W
1640	7/08/89	189	22:15:39	34 44.40N	127 05.30W
1641	7/08/89	189	22:20:29	34 45.50N	126 46.80W
1642	7/08/89	189	22:27:52	34 46.00N	126 29.00W
1643	7/08/89	189	22:32:59	34 47.00N	126 12.00W
1644	7/08/89	189	22:38:00	34 48.00N	125 59.00W
1645	7/08/89	189	22:43:13	34 50.10N	125 26.70W
1646	7/08/89	189	22:47:56	34 51.10N	125 10.00W
1647	7/08/89	189	22:52:43	34 52.20N	124 50.60W
1648	7/08/89	189	22:57:44	34 53.10N	124 31 38W
1649	7/08/89	189	23:07:26	34 55.30N	123 [illegible]2.42W
1650	7/08/89	189	23:10:00	34 56.42N	123 33.00W
1651	7/08/89	189	23:16:58	34 57.43N	123 13.55W
1652	7/08/89	189	23:19:00	34 58.62N	122 54.17W
1653	7/08/89	189	23:28:21	34 59.40N	122 34.10W
1654	7/08/89	189	23:31:00	35 00.58N	122 14.70W
1655	7/08/89	189	23:37:39	35 01.68N	121 55.18W
1656	7/08/89	189	23:40:00	35 02.83N	121 35.90W
1657	7/08/89	189	23:47:07	35 04.12N	121 16.45W
1658	7/08/89	189	23:49:00	35 05.28N	120 57.01W
1901	7/10/89	191	18:12:46	33 57.70N	139 41.70W
1902	7/10/89	191	18:17:12	33 58.60N	139 22.80W
1903	7/10/89	191	18:21:37	33 59.80N	139 04.00W
1904	7/10/89	191	18:26:00	34 00.90N	138 45.10W
1905	7/10/89	191	18:30:42	34 01.80N	138 26.30W
1906	7/10/89	191	18:35:28	34 02.70N	138 07.60W
1907	7/10/89	191	18:40:05	34 04.10N	137 48.80W
1908	7/10/89	191	18.44:48	34 04.50N	137 30.50W
1909	7/10/89	191	18:50:10	34 06.10N	137 11.90W
1910	7/10/89	191	18:54:08	34 06.60N	136 54.00W
1911	7/10/89	191	18:59:07	34 07.40N	136 34.80W
1912	7/10/89	191	19:04:32	34 08.20N	136 16.00W
1913	7/10/89	191	19:09:14	34 09.30N	135 57.30W
1914	7/10/89	191	19:13:59	34 10.30N	135 39.20W
1915	7/10/89	191	19:18:34	34 11.20N	135 20.50W
1916	7/10/89	191	19:23:40	34 12.50N	135 01.50W
1917	7/10/89	191	19:28:03	34 13.60N	134 43.00W
1918	7/10/89	191	19:32:38	34 14.90N	134 23.40W
1919	7/10/89	191	19:38:09	34 16.10N	134 03.80W
1920	7/10/89	191	19:43:16	34 16.40N	133 44.20W
1921	7/10/89	191	19:48:18	34 17.20N	133 25.60W
1922	7/10/89	191	19:53:15	34 18.50N	133 06.60W
1923	7/10/89	191	19:58:11	34 19.60N	132 47.00W
1924	7/10/89	191	20:02:32	34 20.50N	132 29.60W
1925	7/10/89	191	20:06:54	34 21.00N	132 11.70W
1926	7/10/89	191	20:11:43	34 22.30N	131 52.60W
1927	7/10/89	191	20:16:51	34 23.40N	131 32.40W
1928	7/10/89	191	20:21:16	34 24.00N	131 15.20W
1929	7/10/89	191	20:26:00	34 25.50N	130 56.30W
1930	7/10/89	191	20:30:38	34 26.00N	130 38.20W
1931	7/10/89	191	20:35:26	34 26.90N	130 20.10W
1932	7/10/89	191	20:40:12	34 27.80N	130 00.90W
1933	7/10/89	191	20:45:11	34 28.70N	129 41.20W
1934	7/10/89	191	20:50:06	34 29.90N	129 21.80W

1935	7/10/89	191	20:54:46	34 30.90N	129 03.20W
1936	7/10/89	191	20:59:00	34 31.20N	128 44.50W
1937	7/10/89	191	21:09:08	34 33.70N	128 06.60W
1938	7/10/89	191	21:14:17	34 34.70N	127 46.60W
1939	7/10/89	191	21:19:14	34 35.20N	127 27.30W
1940	7/10/89	191	21:24:16	34 35.90N	127 08.30W
1941	7/10/89	191	21:29:06	34 37.10N	126 48.90W
1942	7/10/89	191	21:34:03	34 38.20N	126 29.50W
1943	7/10/89	191	21:38:46	34 39.10N	126 11.10W
1944	7/10/89	191	21:43:42	34 40.20N	125 51.40W
1945	7/10/89	191	21:48:21	34 41.30N	125 32.90W
1946	7/10/89	191	21:53:24	34 42.10N	125 12.70W
1947	7/10/89	191	21:57:54	34 43.10N	124 54.40W
1948	7/10/89	191	22:02:50	34 44.10N	124 36.00W
1949	7/10/89	191	22:07:24	34 45.10N	124 16.20W
1950	7/10/89	191	22:11:50	34 45.50N	123 58.90W
1951	7/10/89	191	22:16:12	34 46.20N	123 43.90W
1952	7/10/89	191	22:21:01	34 49.00N	123 19.70W
1953	7/10/89	191	22:25:42	34 50.60N	122 59.70W
1954	7/10/89	191	22:30:02	34 52.50N	122 40.90W
1955	7/10/89	191	22:34:18	34 54.50N	122 22.70W
1956	7/10/89	191	22:38:52	34 56.10N	122 04.30W
1957	7/10/89	191	22:43:33	34 58.10N	121 46.20W
1958	7/10/89	191	22:47:54	35 00.10N	121 29.90W

IV. ADDITIONAL DATA

a) R/P FLIP: XBT Profiles

This section includes the sound speed profiles calculated from the XBT data collected by R/P FLIP (Figure 14) [4]. The salinity used for these calculations is from the CTD station "fw2" (USNS Narragansett). The calculation method is the same as the one used with the R/V New Horizon XBT data, explained in Appendix A.

TABLE 4: XBT from R/P FLIP [4] (Times are GMT)

Date	Julian Day	Time	Event	Latitude	Longitude
06/28/89	179	19:21	XBT#01	34 00.0N	140 00.0W
07/05/89	186	17:10	XBT#02	34 00.0N	140 00.0W
07/06/89	187	17:30	XBT#03	34 00.0N	140 00.0W
07/06/89	187	17:30	XBT#04	34 00.0N	140 00.0W
07/07/89	188	17:40	XBT#05	34 00.0N	140 00.0W
07/08/89	189	17:27	XBT#06	34 00.0N	140 00.0W
07/09/89	190	19:35	XBT#07	34 00.0N	140 00.0W
07/10/89	191	17:44	XBT#08	34 00.0N	140 00.0W
07/10/89	191	17:54	XBT#09	34 00.0N	140 00.0W
07/11/89	192	17:27	XBT#10	34 00.0N	140 00.0W
07/12/89	193	18:10	XBT#11	34 00.0N	140 00.0W

b) USNS Narragansett CTD Stations

This section includes the sound speed profiles calculated from CTD stations made by USNS Narragansett personnel in the vicinity of R/P FLIP (Figure 15). More details on these data may be found in [3].

TABLE 5: CTD Stations from USNS Narragansett [3] (Times are GMT)

Date	Julian Day	Time	Event	Latitude	Longitude
06/29/89	180	22:55	FW1	34 02.2N	140 00.1W
06/30/89	181	16:37	FW2	34 00.4N	139 58.6W
07/11/89	192	22:35	02	33 48.6N	141 03.0W
07/12/89	193	02:05	38	34 05.0N	141 03.0W

c) R/V New Horizon: Wind Speed and Direction

Included in this section are the stick plots of wind speed and direction recorded aboard the R/V New Horizon from 4 July through 13 July (Figure 16) with notes from Bob Hagg (MPL) who was in charge of processing the data.

Notes from Bob Hagg: Wind Direction

I have determined from reviewing the Serial ASCII Information Loop (SAIL) users manual that wind speed and direction are relative to the ship's speed and course. I have checked this against the wind direction module on board the New Horizon and found wind direction indeed to be relative to the ship's course, i.e. wind direction is measured clockwise from the ship's bow.

The data in file Tape_dat.log, starting at rec. 356, shows what you would expect from relative bearings. The following is a short description of the data.

On Julian day 185 (07-04-89), at approximately 0330 Z the GigaTrend data tape shows the New Horizon on a course of approximately 325 deg., assumed to be gyro, hove to 045 deg. with winds changing from approximately 335 deg. to 270 deg. respectively. The ship then hove to approximately 320 deg. and the winds returned to approximately 340 deg.

The conversion of wind headings from relative to gyro is a simple process, however, it depends on an accurate account of ship's heading information. The ship's heading information, from the GigaTrend tapes, was checked against the ship's log and was found not to consistently match nor disagree. Therefore, I feel the only statement we can make about wind direction is that, wind direction is relative to the ship's direction, and leave it at that. The following examples are ship's log entries and their corresponding GigaTrend data entries.

Source	Time (Z)	SHP HDG (Gyro)	WND HDG	WND SPD (knts)	SHP SPD (knts)
SL	185:1400	330.0	330	18.0	NA
DT	185:0209	329.1	336	26.0	0.0
DT	185:0219	328.0	340	25.2	.02
SL	187:1400	110.0	330	16.0	NA
DT	187:1400	320.2	361	19.8	NA
SL	188:1400	265.0	calm	NA	NA
DT	188:1400	301.6	307	4.1	NA
DT	188:1400	314.6	280	3.4	NA
SL	188:1800	128.0	335	11.0	NA
DT	188:1800	270.	347	11.	NA

SL - Ships Log DT - Data Tape NA - Not Available

ACKNOWLEDGEMENTS

The joint effort of several ship and aircraft crews and scientific parties made possible the collection of data for this experiment. It is particularly appreciated the cooperation of the crew of the R/V New Horizon, specially the heroic battles of Resident Technician Geoffrey Hargraves with the HLF-3 sheave and cable. The useful information contributed by all members of the scientific party in the DSCE log-book, as well as their invaluable help in the "outdoor" activities are also appreciated. Bob Hagg patiently prepared the figures with the ship track, CTD and XBT locations, and HLF-3 depth time series included in this report. He also processed the wind data. Janice Boyd kindly provided Figures 10, 11, 12 and 13 and the data to prepare Figure 9. The XBT data from R/P Flip was provided by John Hildebrand. The satellite images were collected and processed by the Scripps Satellite Oceanography Center and provided by Jim Simpson.

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The members of the scientific party aboard the R/V New Horizon were:

Bill Hodgkiss .... Chief Scientist, MPL- S.I.O.
Marvin Darling ..... Sr. Electronic Technician.
Gerry Denny .... Electronic Supervisor, MPL - S.I.O.
Brian Downs .... Hydroacoustics, Massachussetts.
Gerald D'Spain ..... Graduate Student, MPL - S.I.O.
Greg Edmonds .... Sr. Development Engineeer, MPL - S.I.O.
Dave Ensberg .... Research Associate, MPL - S.I.O.
George Frichter ..... Observer, Naval Ocean Research and Develpment Activity, Mississippi.
Stewart Glegg .... Observer, Florida Atlantic University
Carl Mattson .... Marine Technician, PACODF - S.I.O.
Chris Nickles .... Sr. Development Engineeer, MPL - S.I.O.
Martin Olivera .... Programmer Analyst, MPL - S.I.O.
Glenn Urie .... Naval Ocean Systems Center, San Diego.

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[1] Hodgkiss W.S., J.A. Hildebrand, F.H. Fisher, 1988. "Support Requested for: Downslope Conversion". UCSD-891071.

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[3] Burns D.A., 1989. "TAD Report for VAST 1 Cruise K-1266, USNS Narragansett T-ATF-167, 20 June - 21 July, 1989".

[4] Anonymous, 1989. VAST Expedition: R/P FLIP, June-July, 1989. John Hildebrand Chief Scientist.

[5] Mackenzie K.V., 1981. "Nine-term equation for sound speed in the oceans". J. Acoust. Soc. Am., 70(3), p.807-812.

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APPENDIX A

Calculation of Sound Speed from XBT Temperature and NODC Average or CTD Salinity

Sound Speed (SS) in water is a function of Temperature (T), Salinity (S) and Depth (Z). The equation by Mackenzie [5] is one way to calculate sound speed from these three variables:

$$SS = a + bT - cT^2 + dT^3 + (e - fT)(S - 35) + gZ + hZ^2 - iTZ^3 \quad \text{(A1)}$$

where:

SS is sound speed in meters/sec
T is temperature in degrees Celsius
S is salinity in parts per thousand
Z is depth in meters
a through i are constants

T, S and Z are, in most cases, obtained from CTD casts. Another way to calculate SS with (1) is by using temperature measured through XBT probes. These probes are relatively inexpensive and fast. In addition, they can be launched from aircrafts which makes them very practical. However, XBTs do not measure salinity. This problem is usually solved by using historical salinity[1]. The historical salinity data are in the form of seasonal averages within a determined standard region of the ocean, delimited by geographical coordinates. The quality of sound speed calculated this way is only as good as the fit of the actual to the historical salinity. Presented here is comparison of actual salinity measured during the Downslope Conversion Experiment (station 8, July-1989) with historical salinity for the Area 24 (NODC) months July through September (Figure 5a). The figure shows differences of about 0.5 PPT in salinity in the upper layer, narrowing with depth to neglegible values below 1150 meters. Since sound speed calculations made with either salinity profile are almost identical, the profile from station 8 was used in conjunction with the R/V New Horizon XBT data, due to its better spatial resolution.

An estimate of the differences in sound speed due to differences in salinity can be easily calculated by taking derivative of SS with respect to S in (A1):

$$\frac{\partial SS}{\partial S} = e - fT \quad \text{(A2)}$$

where:

$e = 1.34$ and $f = 0.01025$

Thus, for a given T:

[1] Gerald D'Spain (MPL) wrote a computer program that calculates sound speed profiles using XBT temperature and historical salinity data. See program listing at the end of this appendix.

TABLE A-1

T(C)	DELTA S(ppt)	DELTA SS(m/s)
2	0.2	0.264
2	0.3	0.296
5	0.1	0.129
5	0.2	0.258
5	0.3	0.387
10	0.4	0.495
15	0.5	0.593
20	1.0	1.135
20	1.5	1.702
20	2.0	2.270

It is clear from Figure 5a that ΔS decreases with Z. However, depending on the accuracy needed, ΔSS may still be considerable (about 0.3 m/sec) for typical values of T and ΔS at deep layers, as shown in TABLE A-1.

Summarizing, one must be very careful when considering the use of XBT probes, instead of the more complete CTD casts, for later calculation of sound speed. This is particularly critical when sound speed accuracy of about 1.0 m/sec (and sometimes of about 2 m/sec) or better is required. This method seems appropriate when dealing with low and medium frequencies (up to approximately 350 to 380 Hz, or wavelength of 4 meters).

Listing of FORTRAN Program

```
C Program XBT2SS.f
C This program reads XBT temperature ASCII data files (file
C name prompted for), and a salinity data file "ZS.TXT" (CTD
C data or NODC historical average) applicable to the area
C where the XBT was taken. It then calculates a sound speed
C profile from the equation in MacKenzie, JASA 70 (3), p.808,
C Sept., 1981., and outputs to a file "SSPTMP".
C
C Original code by Gerald D'Spain (7-89).
C Modified code: Martin Olivera (10-89)
C
      IMPLICIT REAL*4 (A-H,O-Z)
      DIMENSION ZZ(2500), SS(2500), XBTZ(4000), XBTT(4000)
      CHARACTER*15 FILNM1
      INFL1=8
      INFL2=9
      IOFLA=10
C
      WRITE(*,*) '
      WRITE(*,'(//)')
      WRITE(6,100)
 100  FORMAT(1X, '* ENTER INPUT XBT DATA FILENAME  --> '?)
      READ(5,2) FILNM1
   2  FORMAT(A15)
C
      OPEN(INFL1,IOSTAT=IERB,ERR=888,FILE=FILNM1,STATUS='OLD')
      OPEN(INFL2,IOSTAT=IERB,ERR=666,FILE='ZS.TXT',STATUS='OLD')
      OPEN(IOFLA,IOSTAT=IERB,ERR=777,FILE='SSPTMP',STATUS='NEW')
C
C***************************
C ** Read data from XBT file
C***************************
      DO 5 I=1,4000
        READ(INFL1,1,END=6) XBTZ(I), XBTT(I)
   1    FORMAT(F6.1,3x,F5.2)
   5  CONTINUE
C
C*******************************
C ** Input Salinity vs Depth data
C*******************************
   6  NP=I-1
      DO 7 I=1,2500
        READ(INFL2,3,END=8) ZZ(I), SS(I)
   3    FORMAT(11X, F6.1, 6X, F6.3)
   7  CONTINUE
C
C************************************************************
C ** Calculate the sound speed profile assuming that the salinity
C    is that at the nearest depth BELOW the xbt depth.
C************************************************************
   8  J=1
      DO 70 I = 1, NP
```

```
      Z = XBTZ(I)
      T = XBTT(I)
C
      IF (Z.LE.ZZ(J))  THEN
       S = SS(J)
      ELSE
       J = J + 1
      ENDIF
C
      C=1448.96 + 4.591*T - 0.05304*T*T + 0.0002374*T*T*T
      C=C + (1.34 - 0.01025*t)*(S-35.0)
      C=C + 0.0163*Z + 0.0000001675*Z*Z - 0.007139e-10*T*Z*Z*Z
C
      WRITE(IOFLA,333) Z,C
 333   FORMAT(1X, F6.1,3X, F6.1)
C
  70 CONTINUE
C
  80 CLOSE(INFL1)
     CLOSE(INFL2)
     CLOSE(IOFLA)
C
     STOP
C
C
 888 WRITE(6,887) FILNM1
 887 FORMAT(1X,'** Error in opening XBT input file ', A3)
     STOP
C
 666 WRITE(6,665)
 665 FORMAT(1X,'** Error in opening Salinity input file, ZS.TXT')
     STOP
C
 777 WRITE(6,776)
 776 FORMAT(1X,'** Error in opening output file, SSPTMP')
     STOP
C
     END
---------------------------------------------------------------
```

APPENDIX B

Satellite Imagery

The following is a list of all the satellite infrared images provided by the Scripps Satellite Oceanography Center. Black and white xerox copies of the original color pictures are included. In the pictures, the proposed cruise track lines are overlayed.

TABLE B-1: Satellite Images

Picture #	Date	Julian Day	Time (GMT)
01	06-17-89	168	N-A
02	06-18-89	169	N-A
03	06-19-89	170	N-A
04	06-20-89	171	N-A
05	06-25-89	176	N-A
06	06-26-89	177	N-A
07	06-28-89	179	N-A
08	07-01-89	182	21:14
09	07-02-89	183	21:05
10	07-03-89	184	20:54
11	07-04-89	185	20:44
12	07-05-89	186	22:15
13	07-06-89	187	22:04
14	07-07-89	188	21:53
15	07-13-89	194	20:51

FIGURE CAPTIONS

Figure 1: Proposed source towing lines for R/V New Horizon. Down Slope Conversion Experiment.

Figure 2: Actual cruise track. R/V New Horizon. Downslope Conversion Experiment, 1-14 July, 1989. (July 1 is Julian Day 182)

Figure 3: Location of CTD stations during the Downslope Conversion Experiment, 1-14 July, 1989.

Figure 4: Sound speed profiles from the CTD stations made during the Downslope Conversion Experiment, 1-14 July, 1989.

Figure 5: Salinity (a) and Temperature (b) profiles for CTD station 8 (jagged curve) and NODC July-September Average (smoother curve).

Figure 6: Location of XBT launches during the Downslope Conversion Experiment, 1-14 July, 1989.

Figure 7: Sound speed profiles calculated from XBT data collected during the Downslope Conversion Experiment.

Figure 8 (a, b, c, d): HLF-3 depth time series as measured with an attached pressure gauge. Each graph corresponds to periods in which the HLF-3 was in the water.

Figure 9: Temperature profiles from AXBT launches: (a) Line-1; (b) Line-2; (c) Line-3.

Figure 10: Temperature Vertical Sections (a) Line-1; (b) Line-2; (c) Line-3.(Furnished by Janice Boyd, NORDA).

Figure 11 (a, b, c): "Waterfall" Temperature plot (Line-1)(Furnished by Janice Boyd, NORDA).

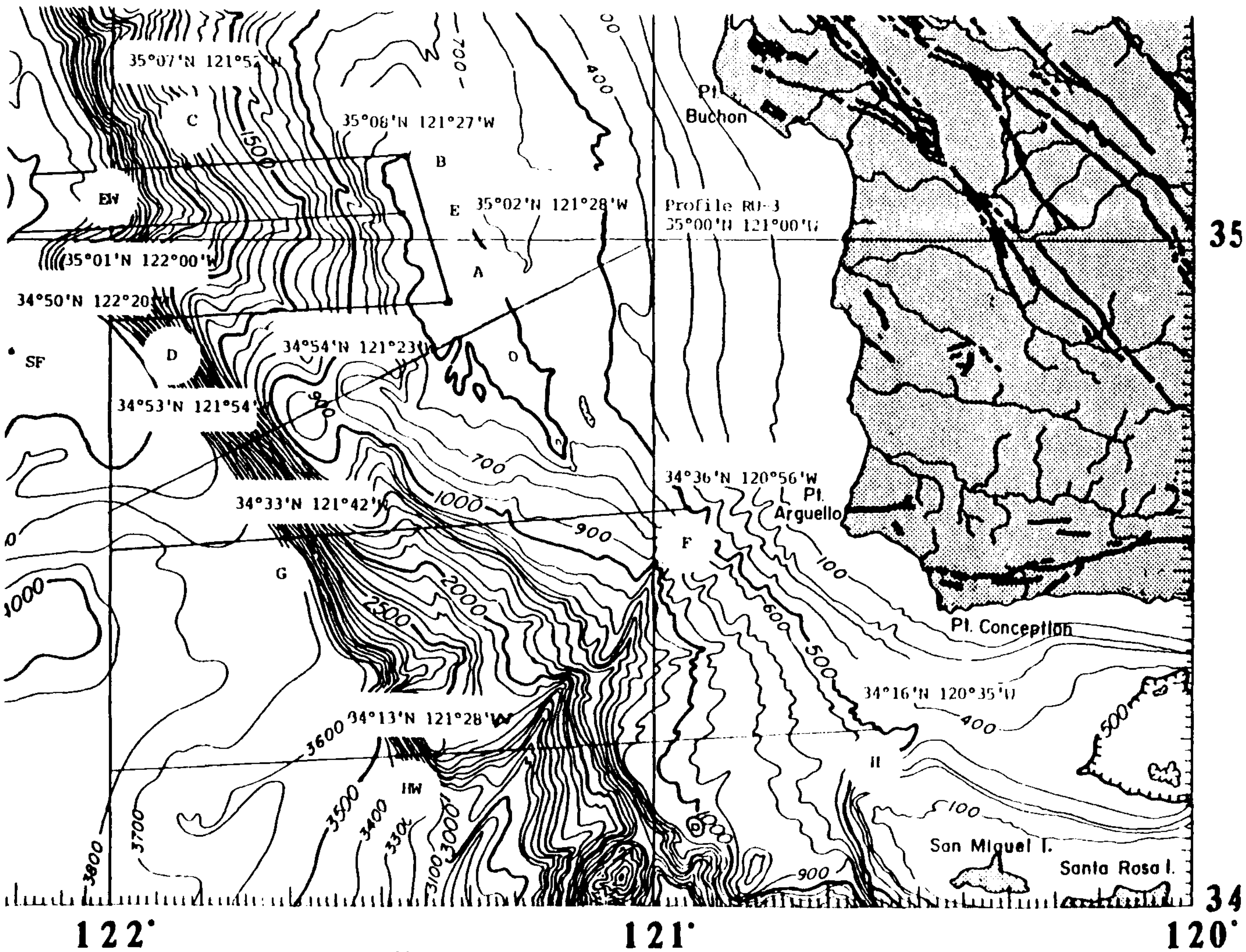
Figure 12 (a, b, c): "Waterfall" Temperature plot (Line-2)(Furnished by Janice Boyd, NORDA).

Figure 13 (a, b, c): "Waterfall" Temperature plot (Line-3)(Furnished by Janice Boyd, NORDA).

Figure 14: Sound speed profiles calculated from XBT data collected by R/P FLIP at 34 00.0 N and 134 00.0 W.

Figure 15: Sound speed profiles from the CTD stations made by the USNS Narragansett in the vicinity of R/P FLIP.

Figure 16: Stick plots of wind speed and direction recorded aborad the R/V New Horizon during the Downslope Conversion Experiment. Direction is TRUE north and computed with respect to the ship's gyro.


35°07'N 121°52'W
C
35°08'N 121°27'W
B
EW
E
35°02'N 121°28'W
Profile RU-3
35°00'N 121°00'W
Pt.
Buchon
35°01'N 122°00'W
A
34°50'N 122°20'W
34°54'N 121°23'W
D
SF
34°53'N 121°54'W
34°36'N 120°56'W
Pt.
Arguello
34°33'N 121°42'W
F
G
Pt. Conception
34°16'N 120°35'W
34°13'N 121°28'W
H
HW
San Miguel I.
Santa Rosa I.
35
34
122°
121°
120°
Figure 1.

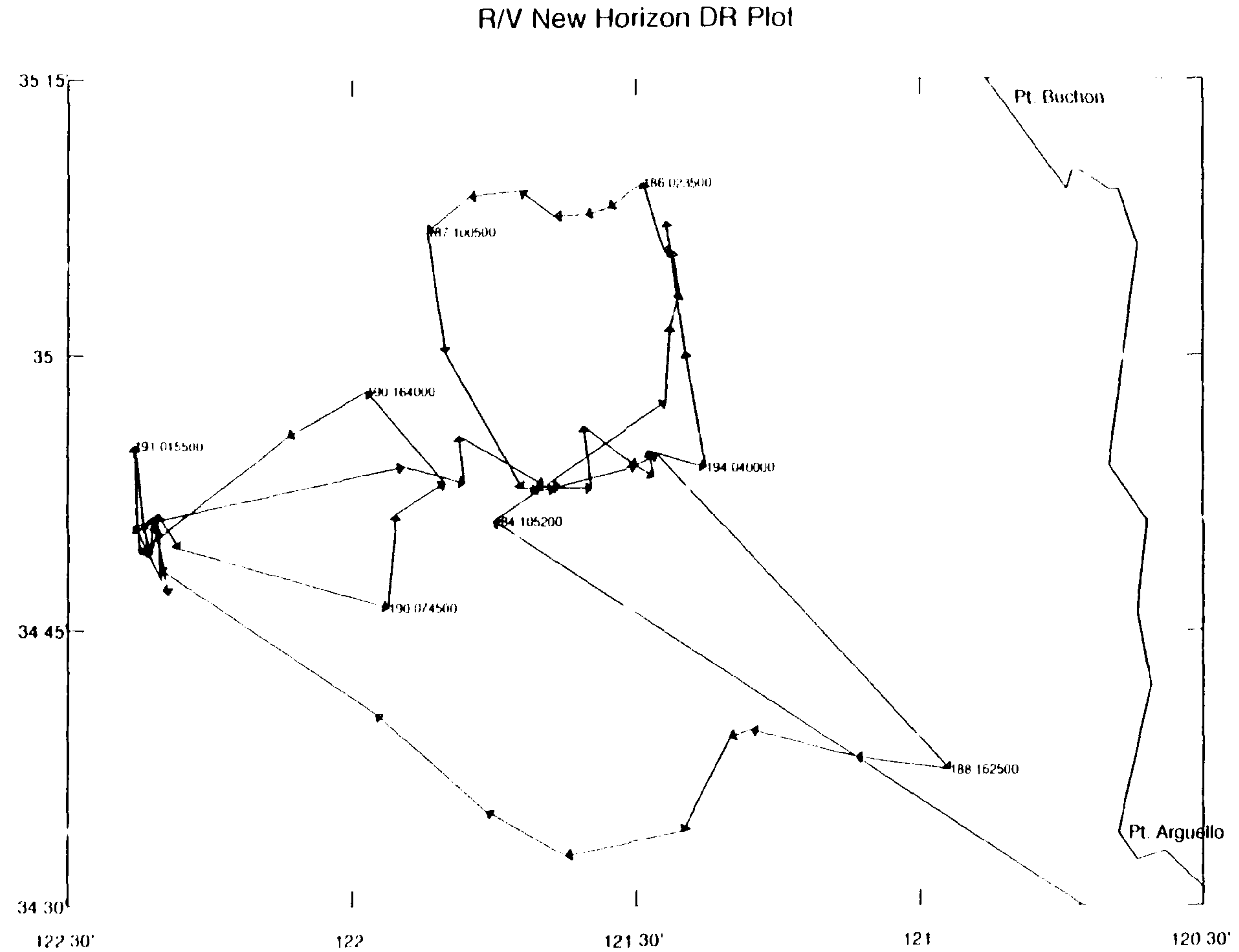


Figure 2. Ship track based on XBT locations

R/V New Horizon CTD Sites, 1-14 July '89

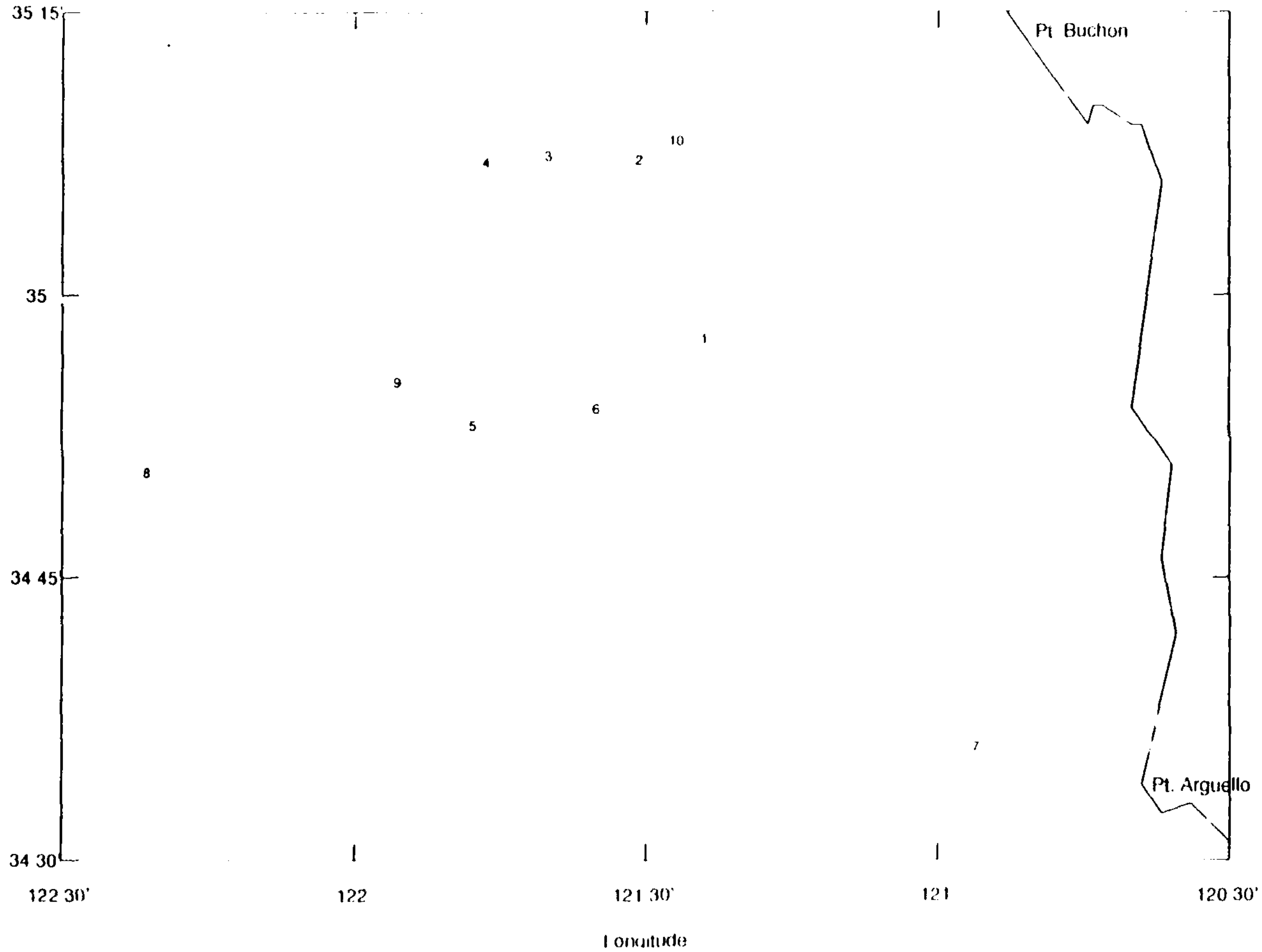
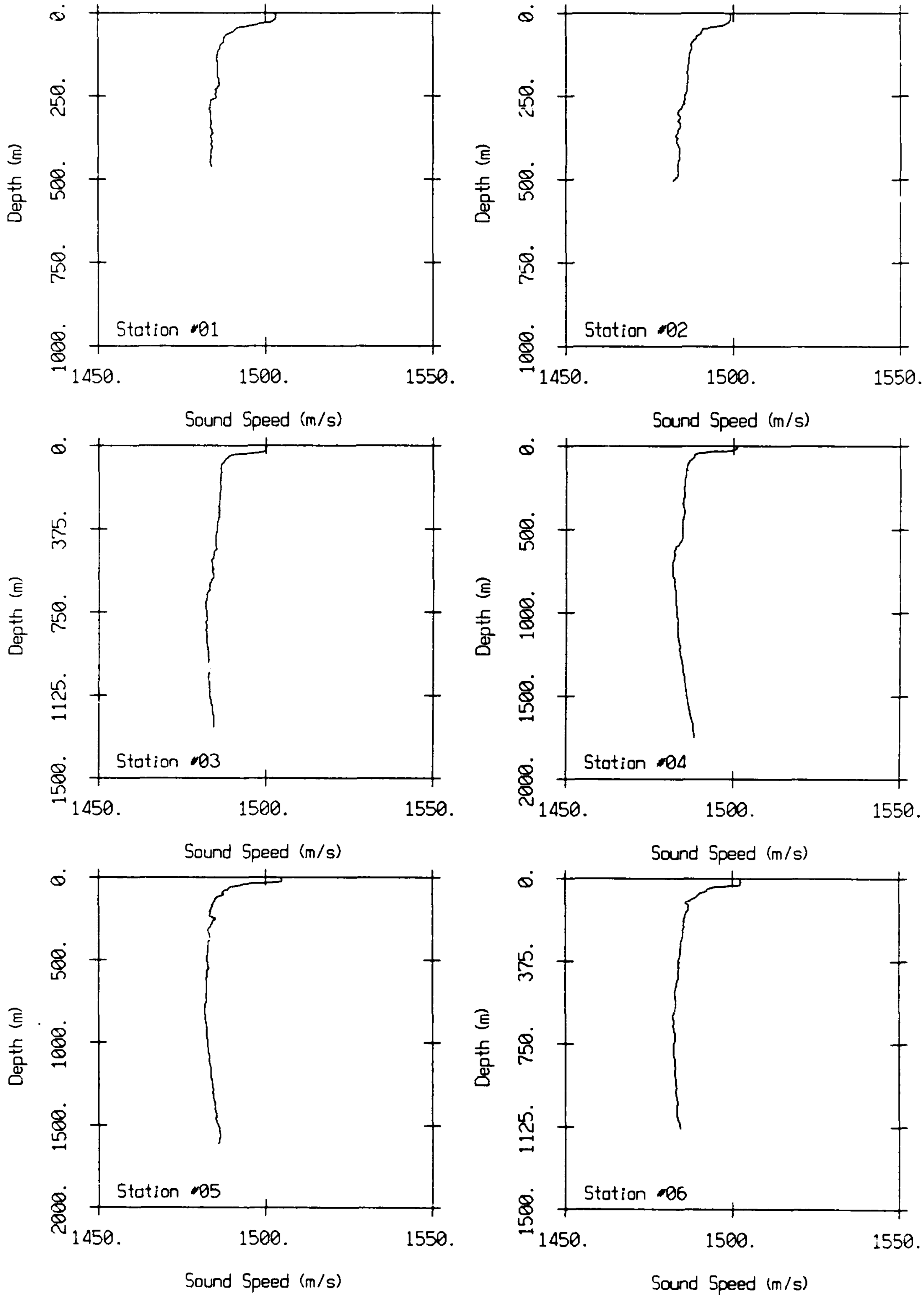


Figure 3



Station #01
Station #02
Station #03
Station #04
Station #05
Station #06
Depth (m)
Sound Speed (m/s)
0.
250.
500.
750.
1000.
375.
1125.
1500.
2000.
1450.
1500.
1550.

Figure 4.

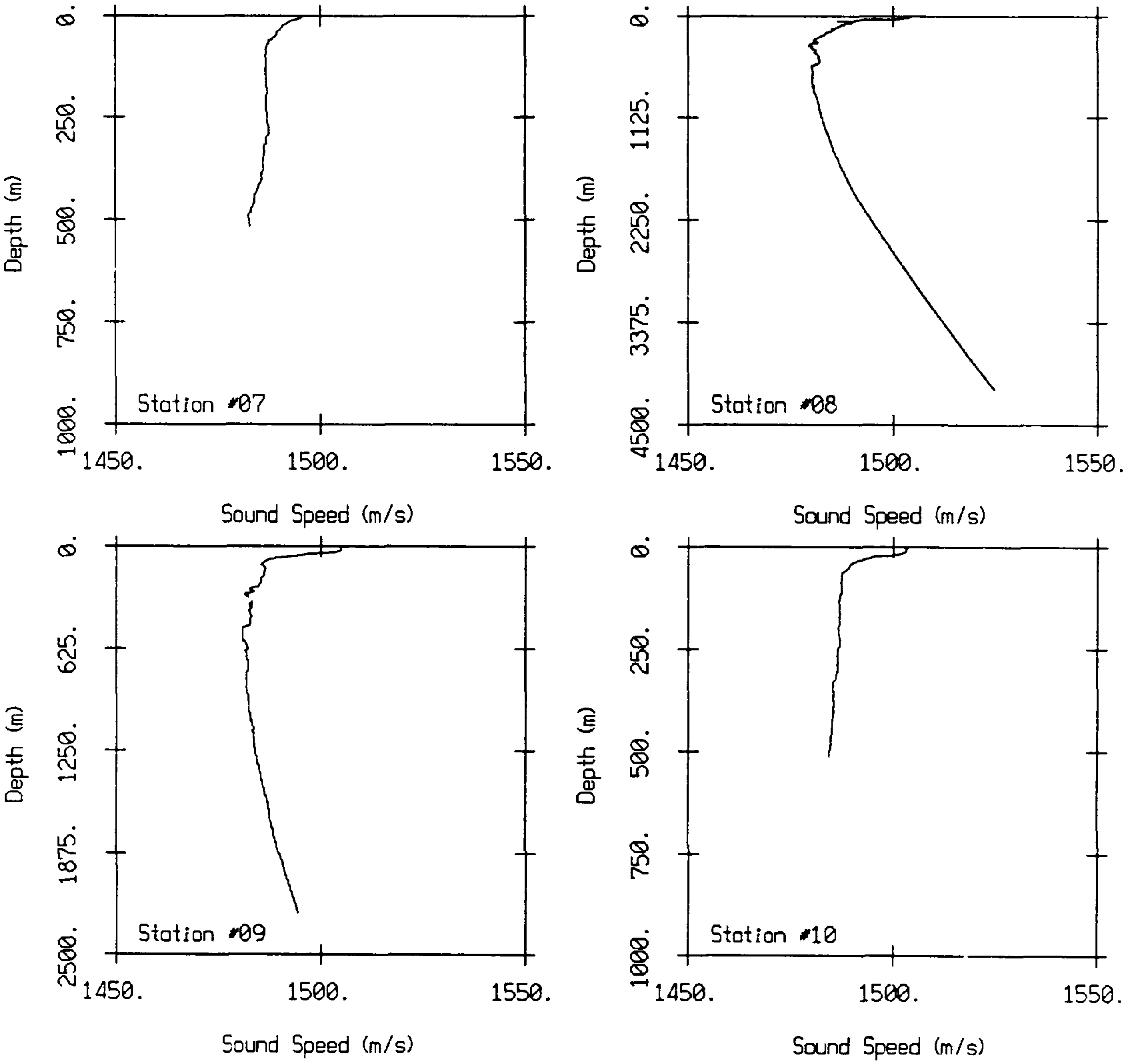


Figure 4. (cont.)

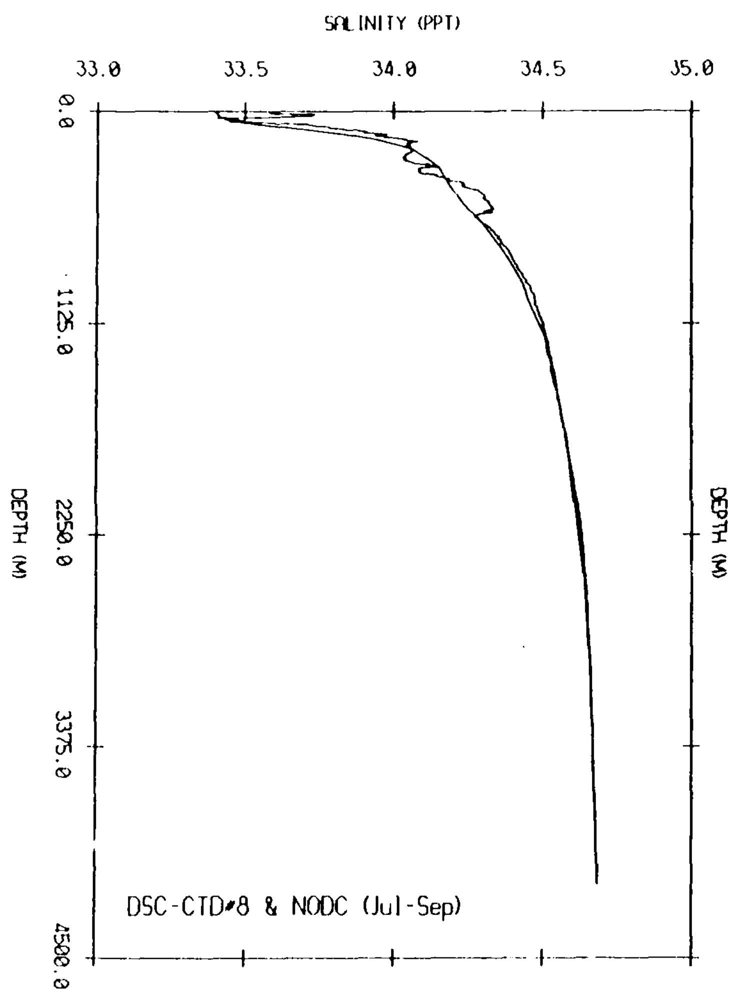


Figure 5 (a).

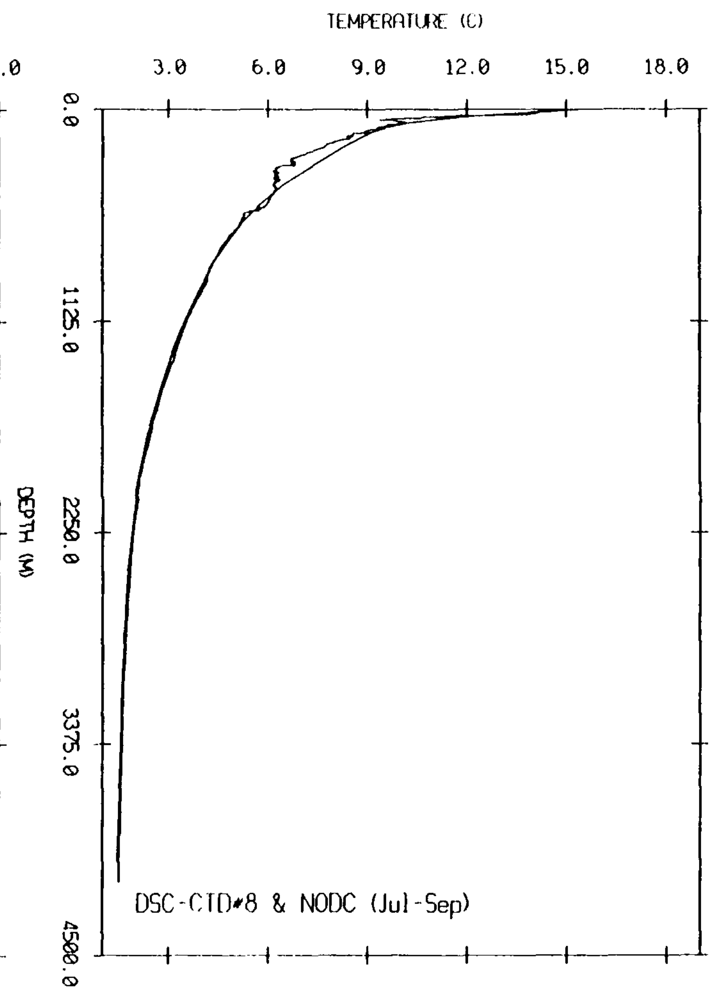


Figure 5 (b).

R/V New Horizon XBT Sites, 1-14 July '89

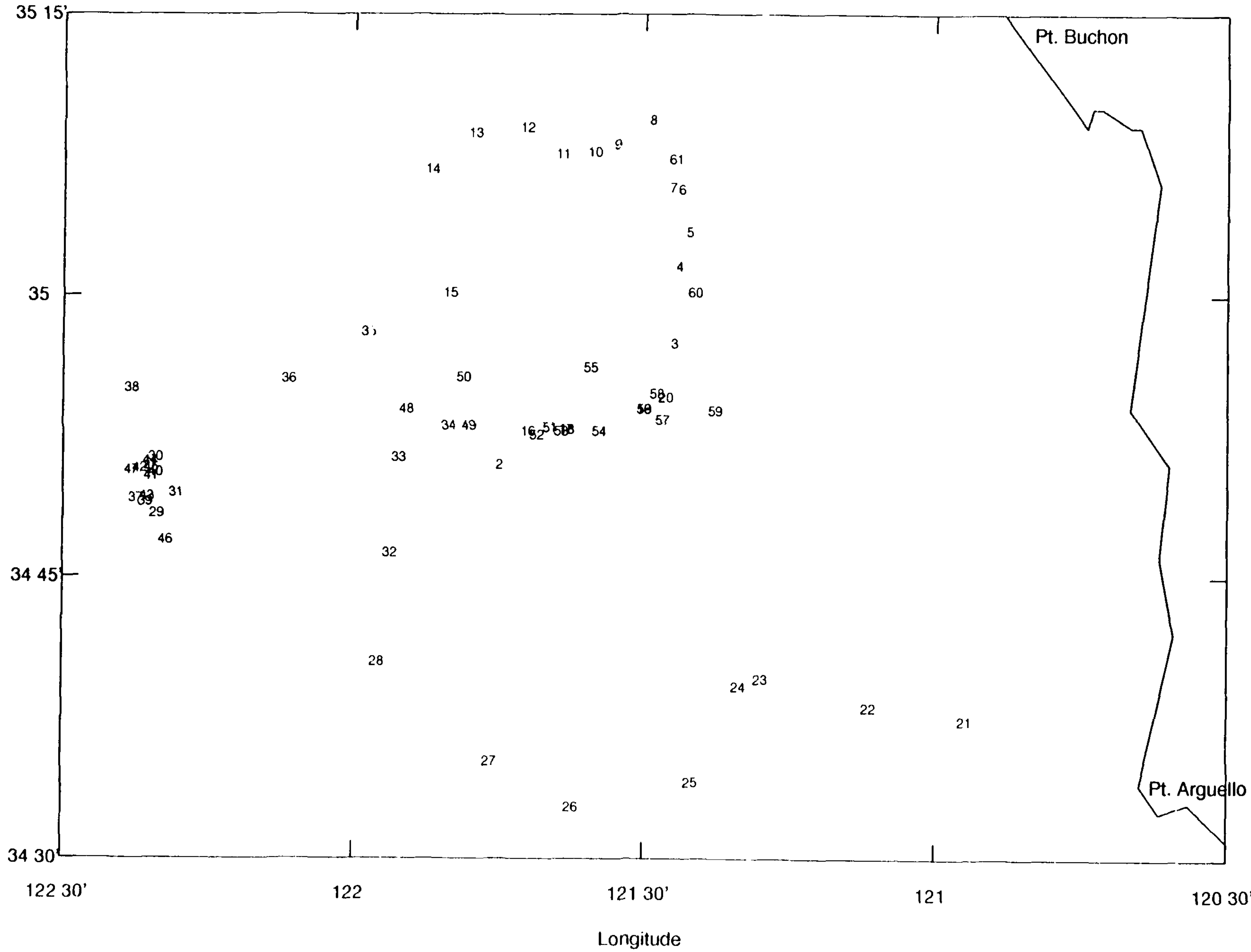


Figure 6.

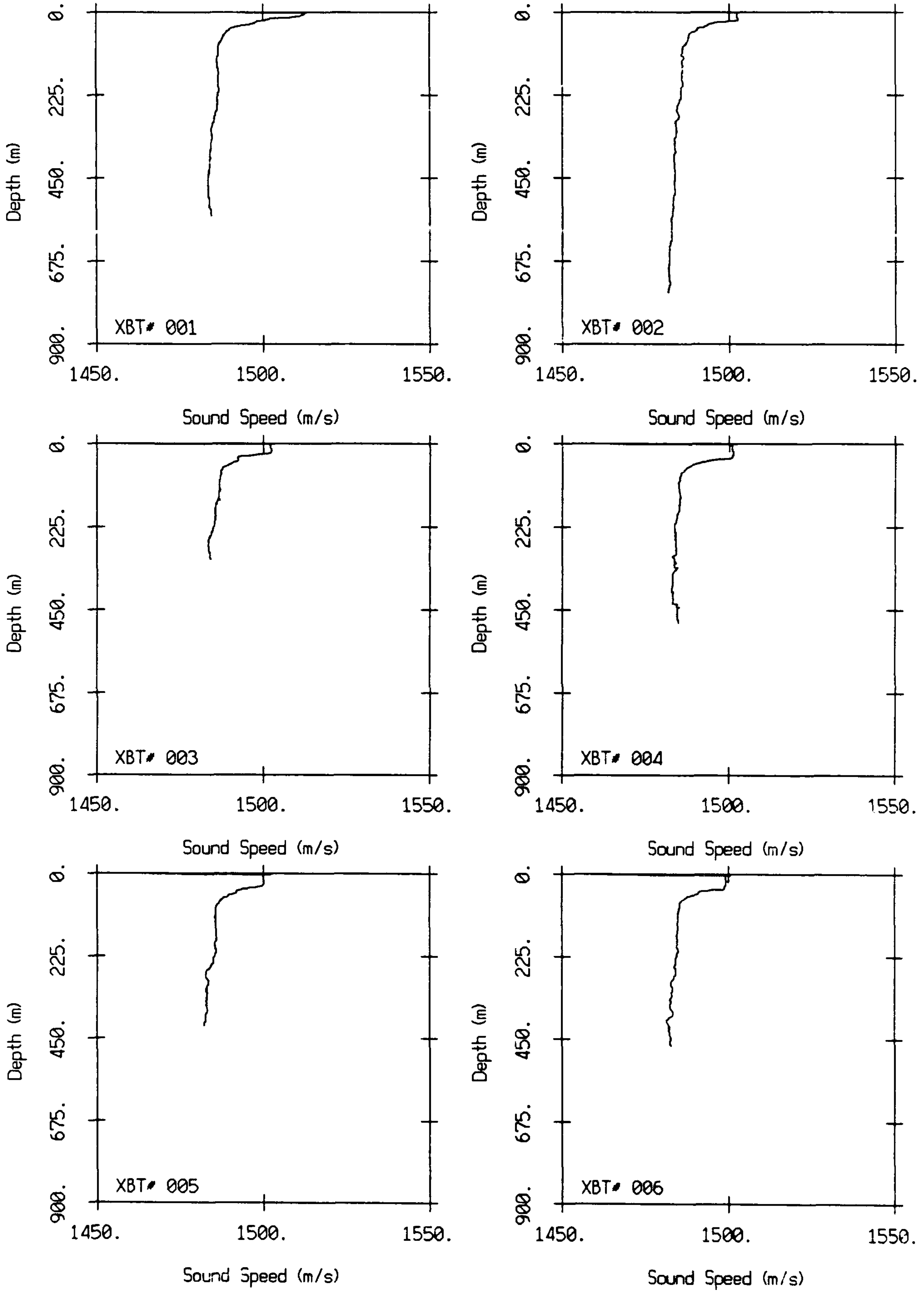

Depth (m)
0.
225.
450.
675.
900.
1450.
1500.
1550.
Sound Speed (m/s)
XBT# 001
XBT# 002
XBT# 003
XBT# 004
XBT# 005
XBT# 006

Figure 7.

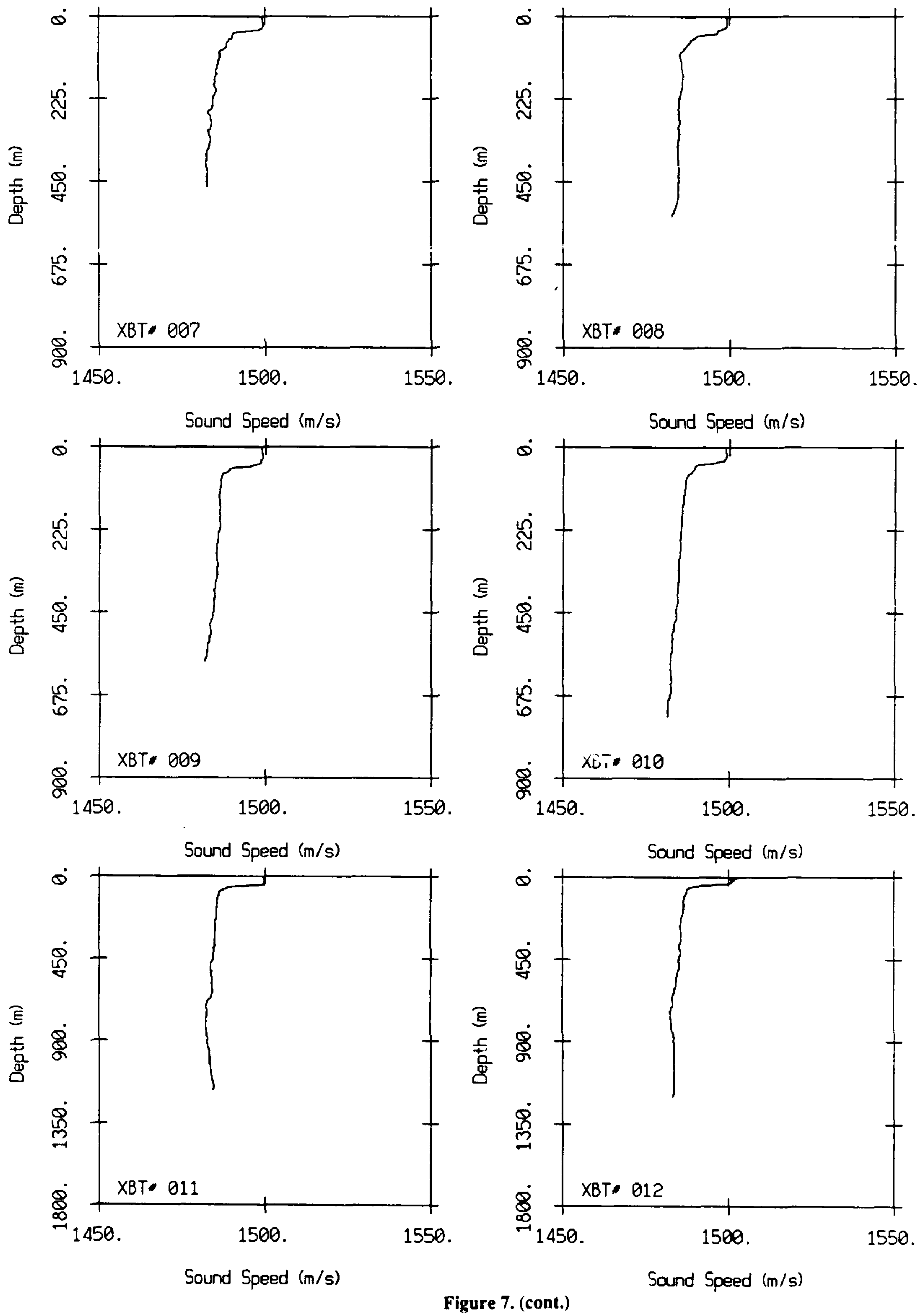


Figure 7. (cont.)

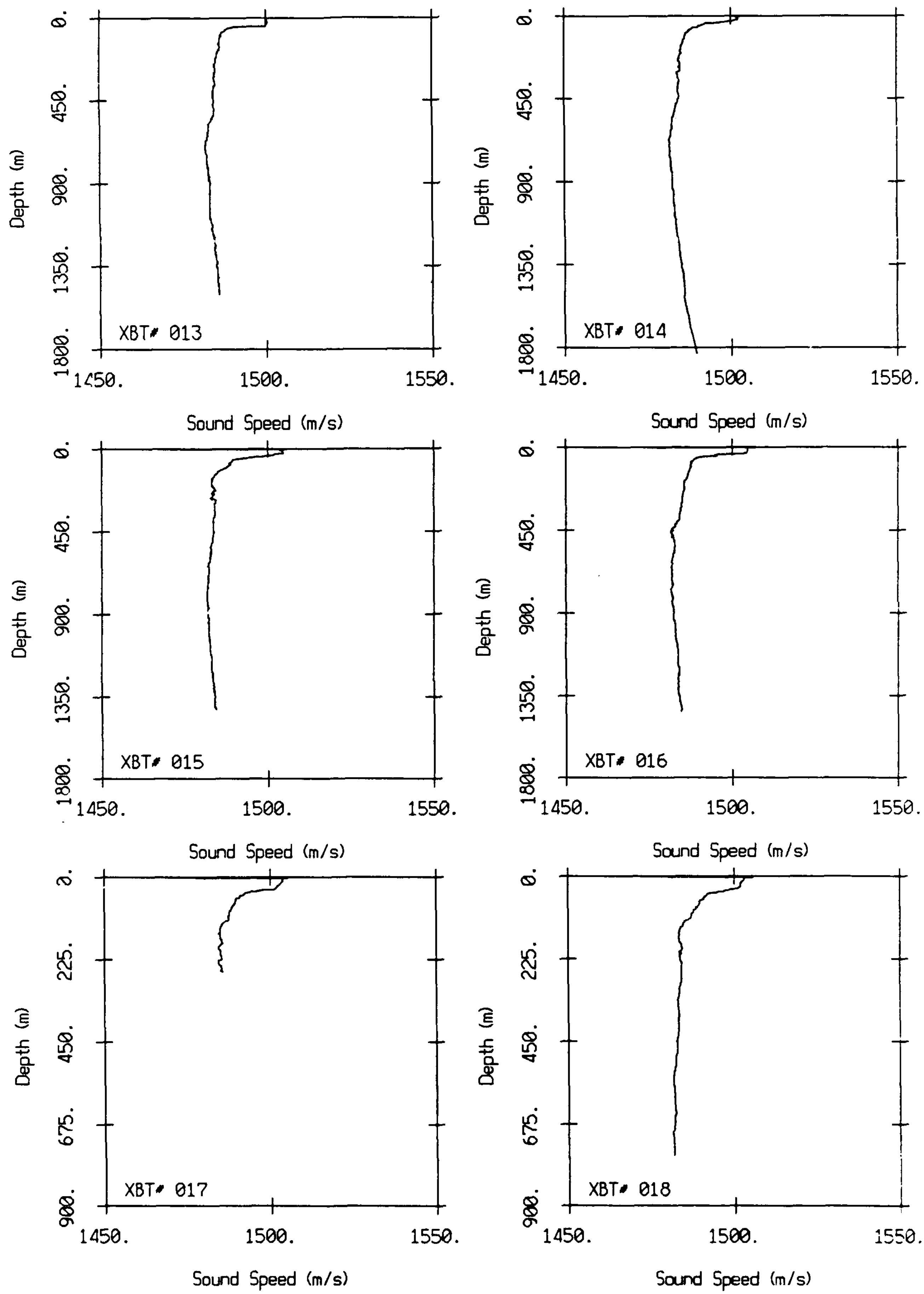


Figure 7. (cont.)

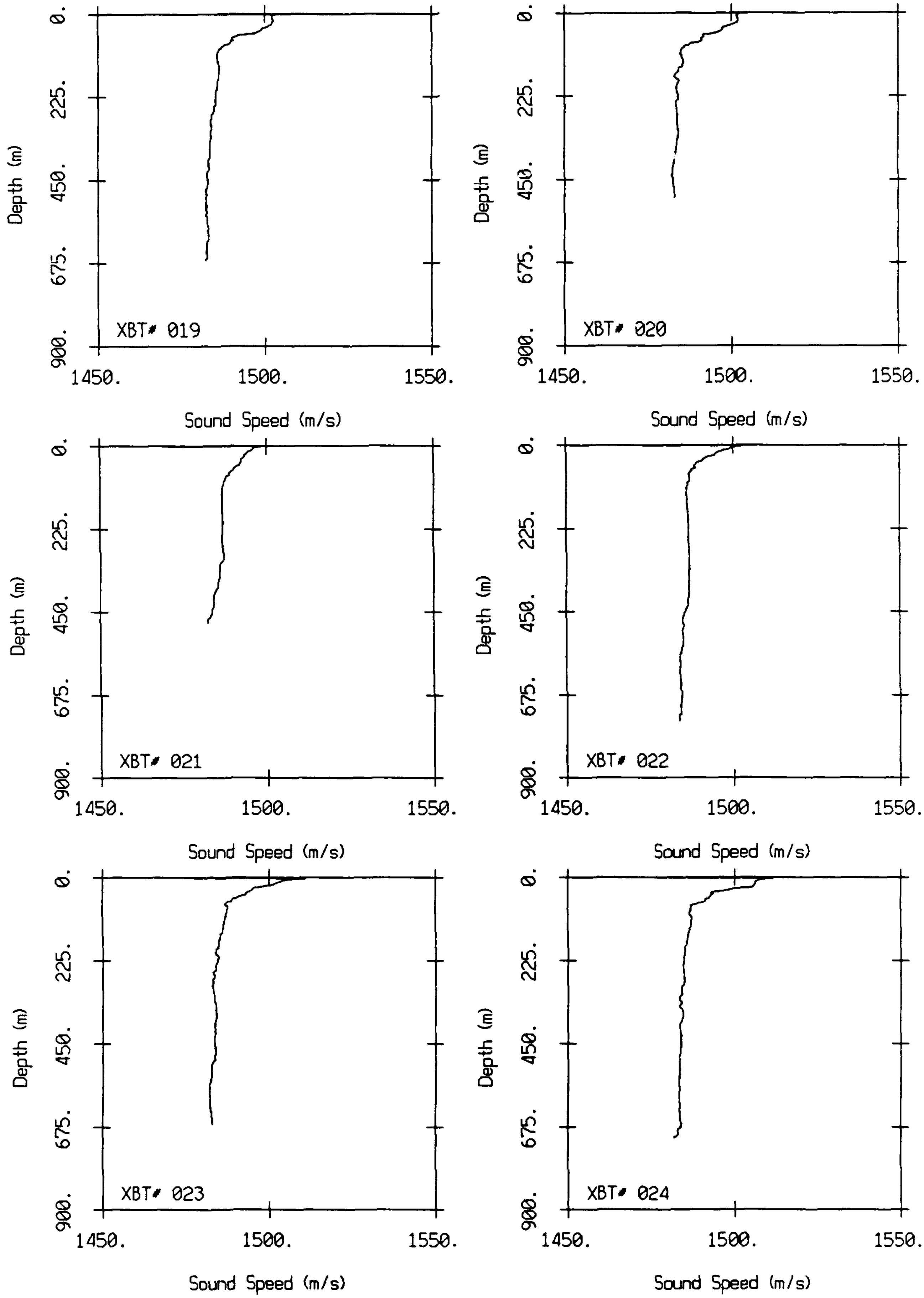


Figure 7. (cont.)

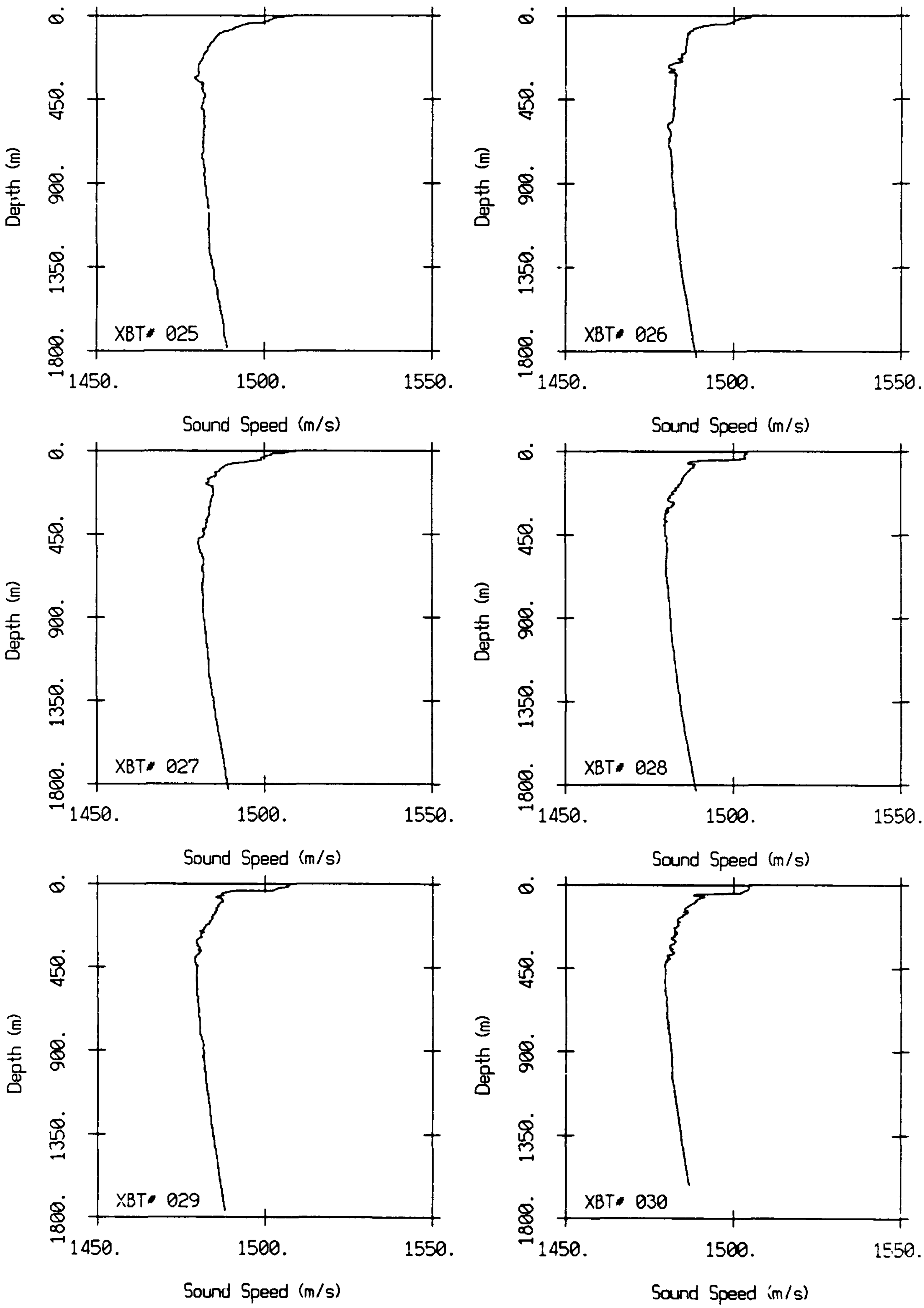


Figure 7. (cont.)

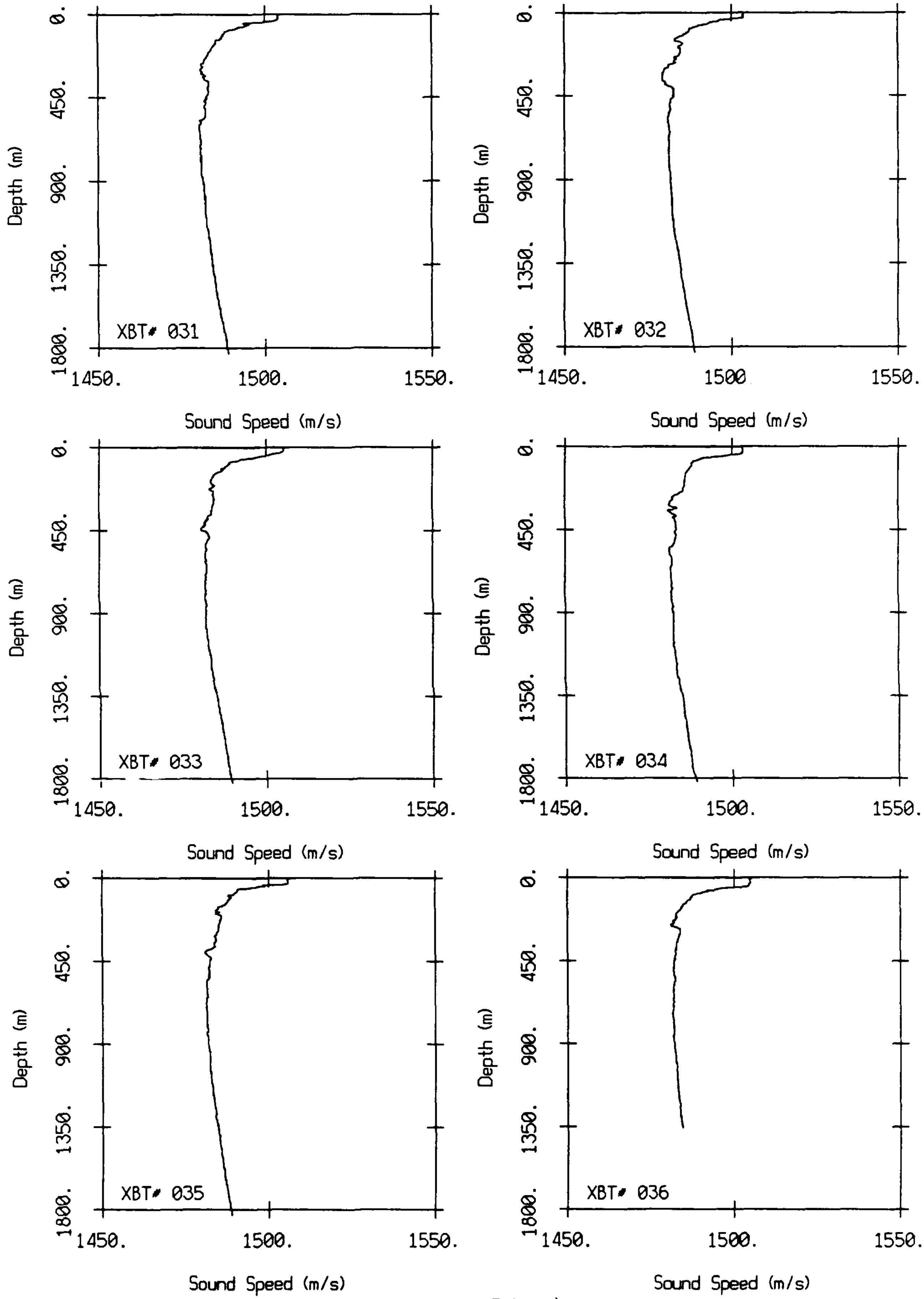


Figure 7. (cont.)

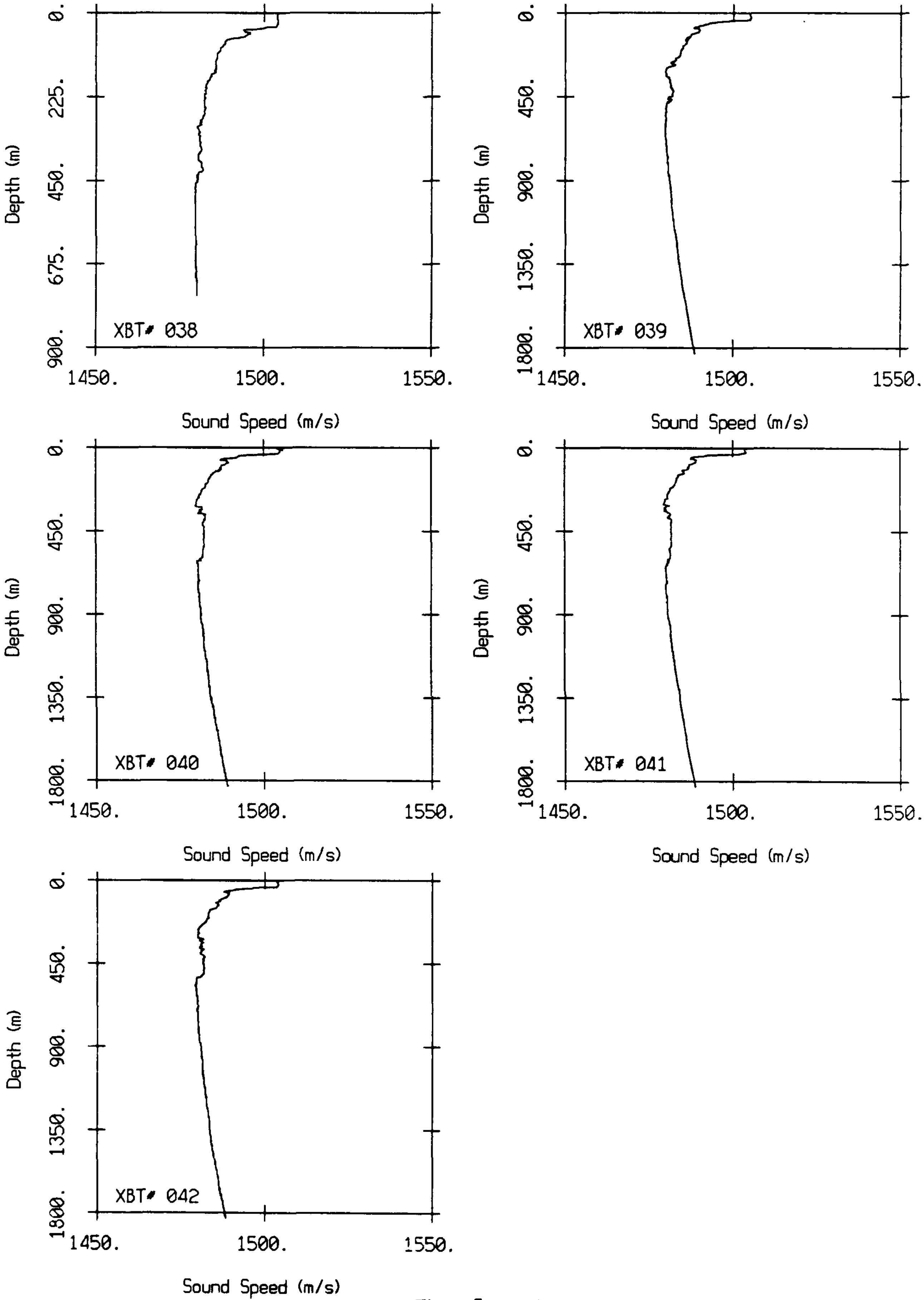


Figure 7. (cont.)

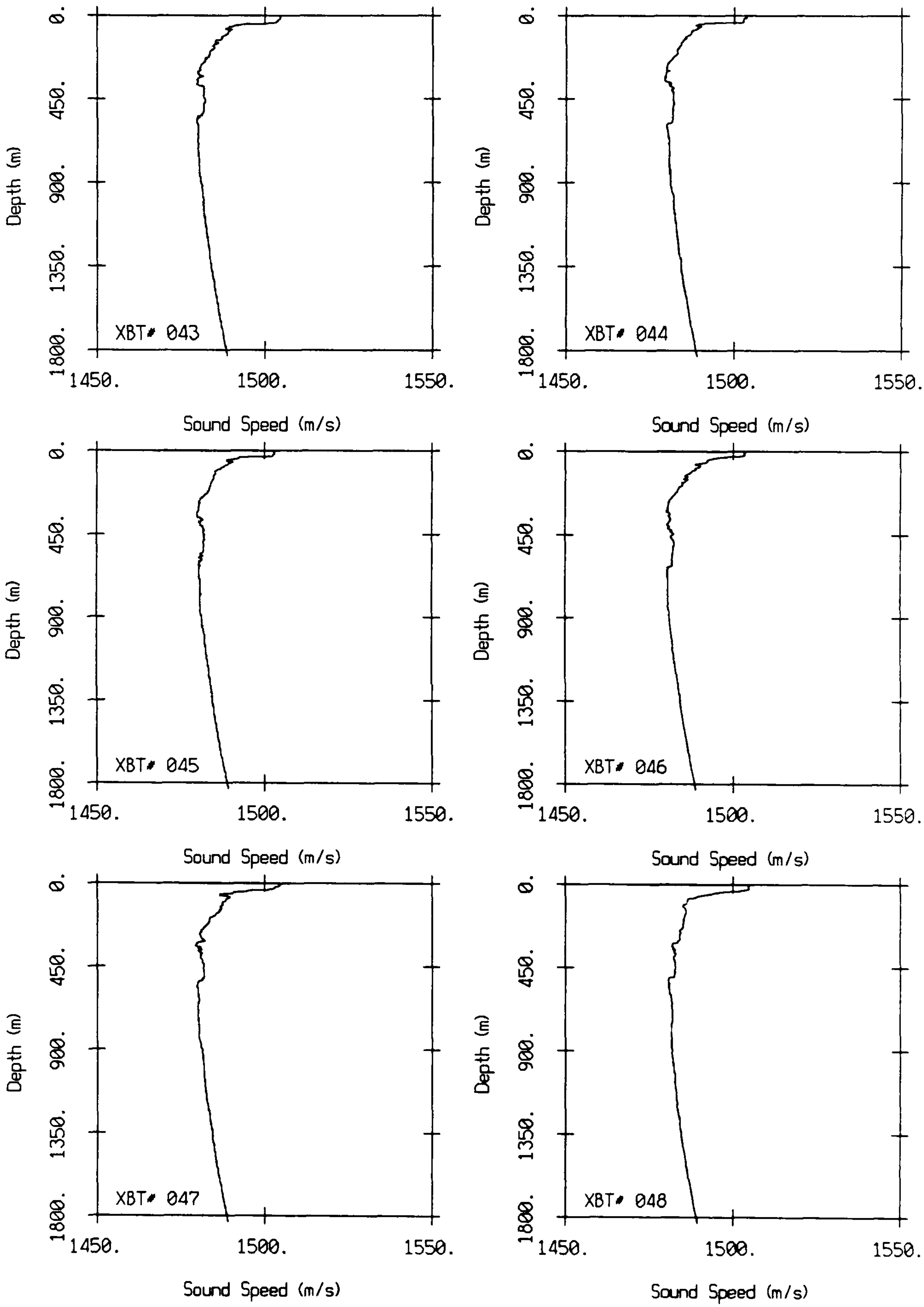


Figure 7. (cont.)

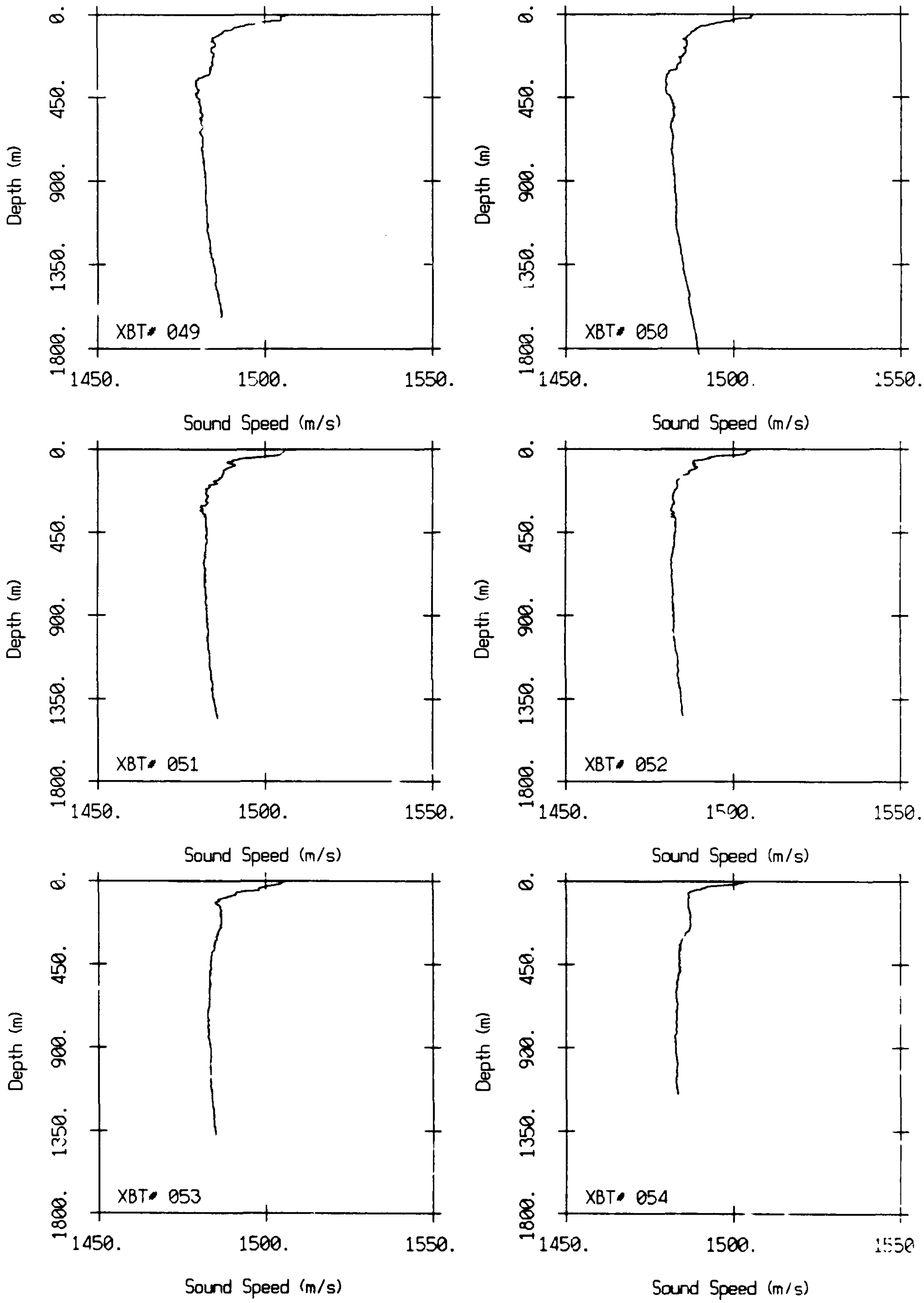


Figure 7. (cont.)

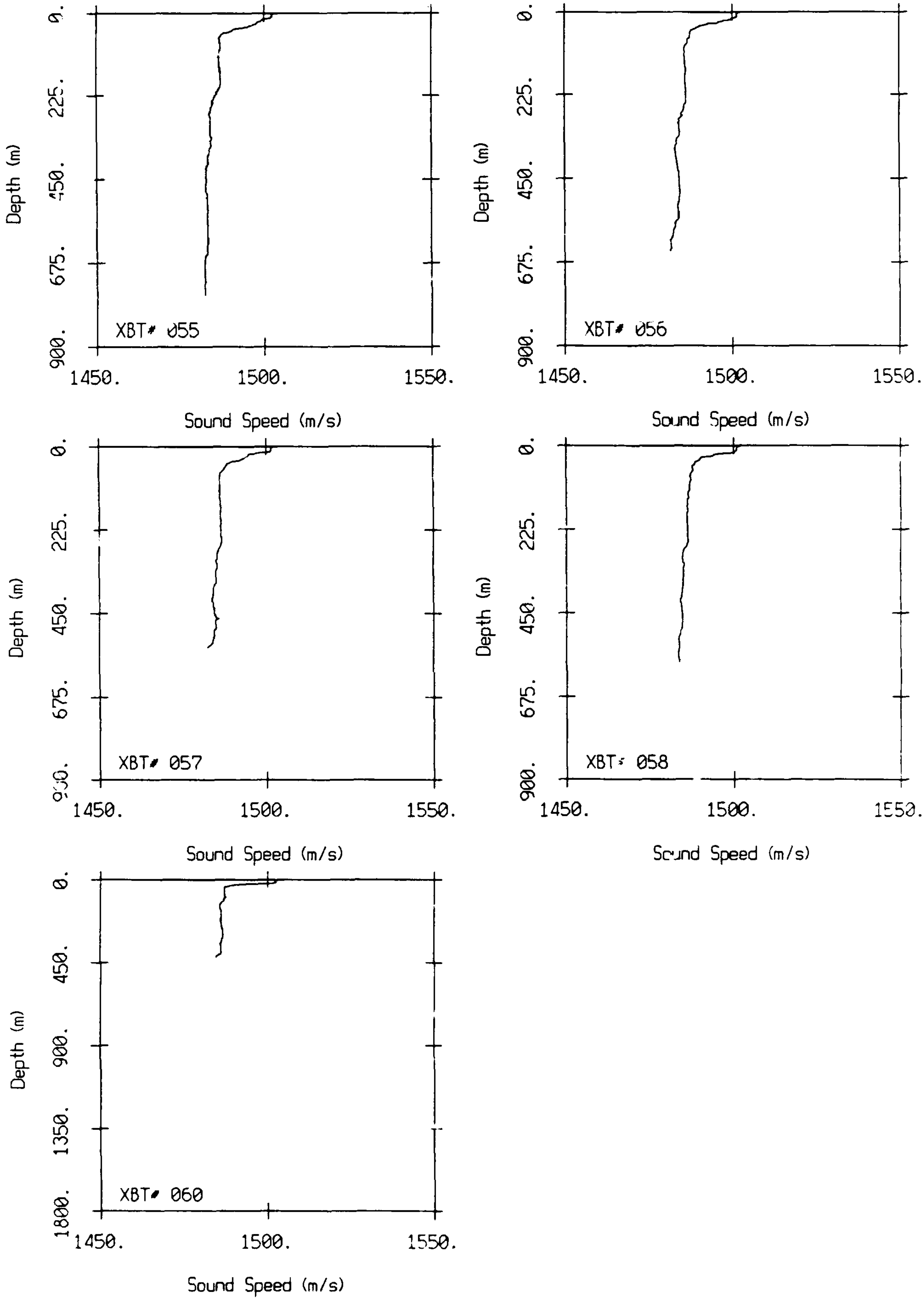


Figure 7. (cont.)

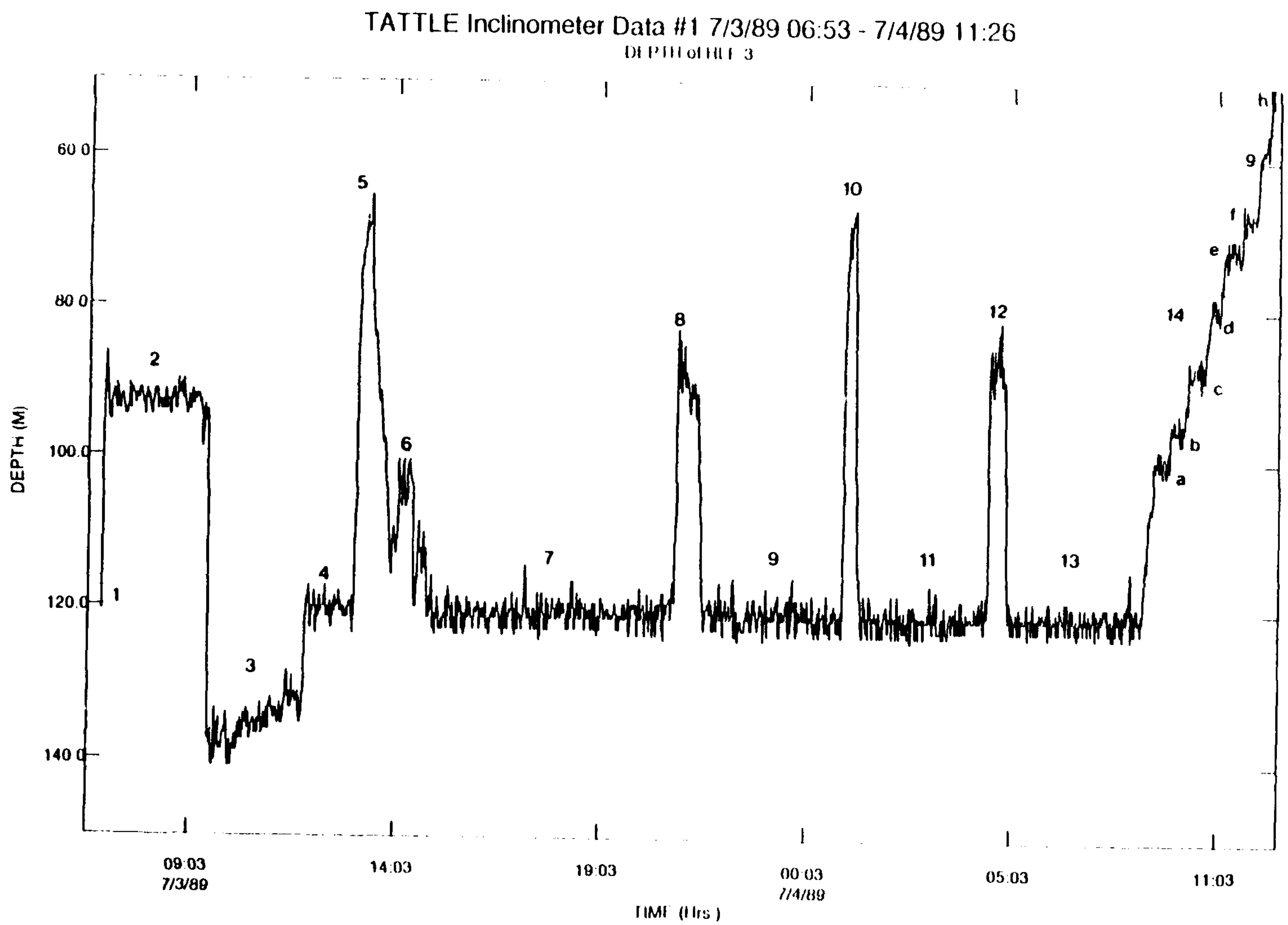
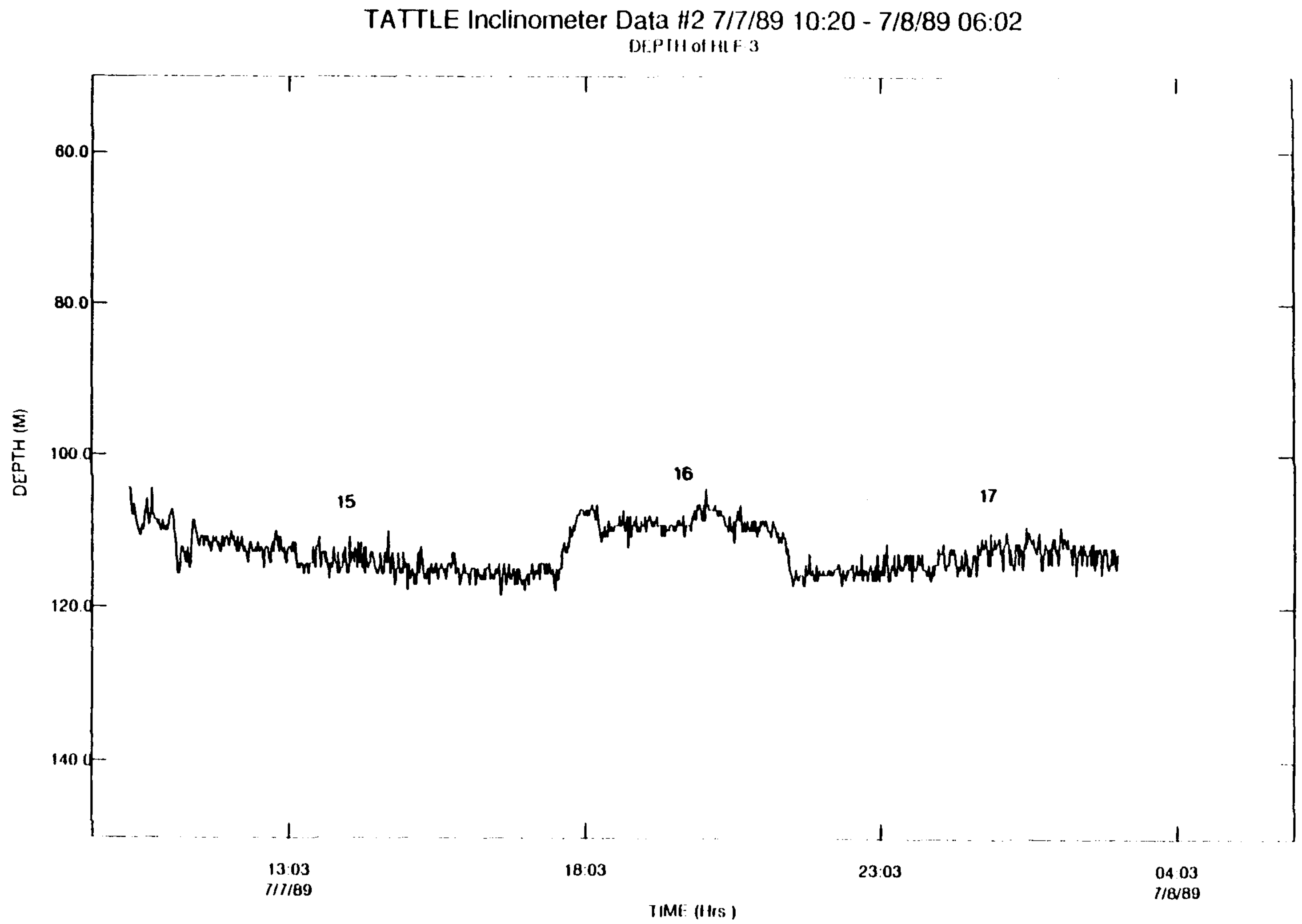
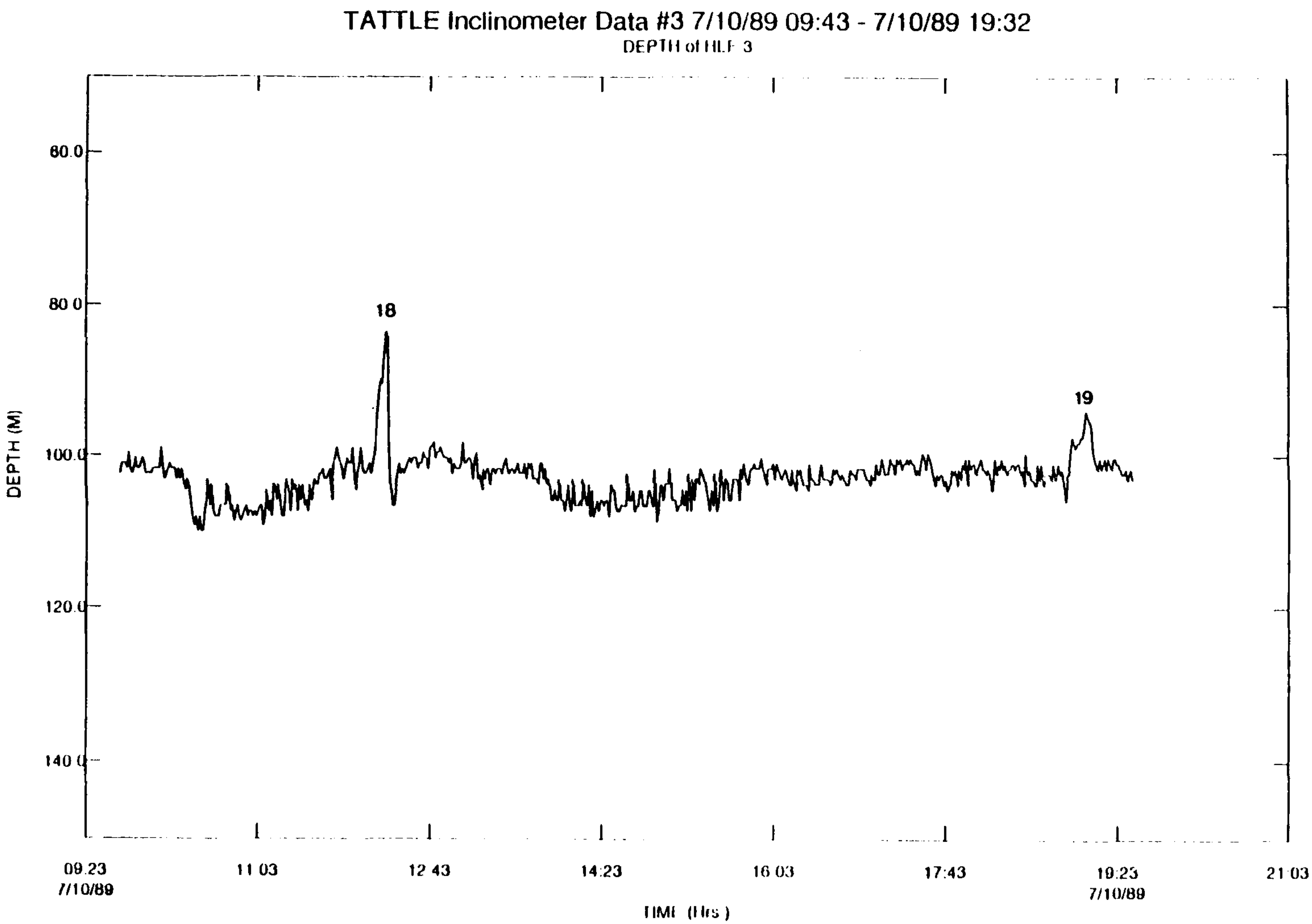

TATTLE Inclinometer Data #1 7/3/89 06:53 - 7/4/89 11:26
DEPTH (M)
60 0
80 0
100.0
120.0
140 0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
a
b
c
d
e
f
h
09:03
7/3/89
14:03
19:03
00:03
7/4/89
05:03
11:03

Figure 8 (a).



TATTLE Inclinometer Data #2 7/7/89 10:20 - 7/8/89 06:02
DEPTH of HLF 3
60.0
80.0
100.0
120.0
140.0
DEPTH (M)
15
16
17
13:03
7/7/89
18:03
23:03
04:03
7/8/89
TIME (Hrs)

Figure 8 (b).



TATTLE Inclinometer Data #3 7/10/89 09:43 - 7/10/89 19:32
DEPTH of HLF 3
60.0
80.0
100.0
120.0
140.0
DEPTH (M)
18
19
09:23
7/10/89
11:03
12:43
14:23
16:03
17:43
19:23
7/10/89
21:03
TIME (Hrs)

Figure 8 (c).

TATTLE Inclinometer Data #4 7/11/89 12:40 - 7/13/89 05:52

DEPTH of HLF-3

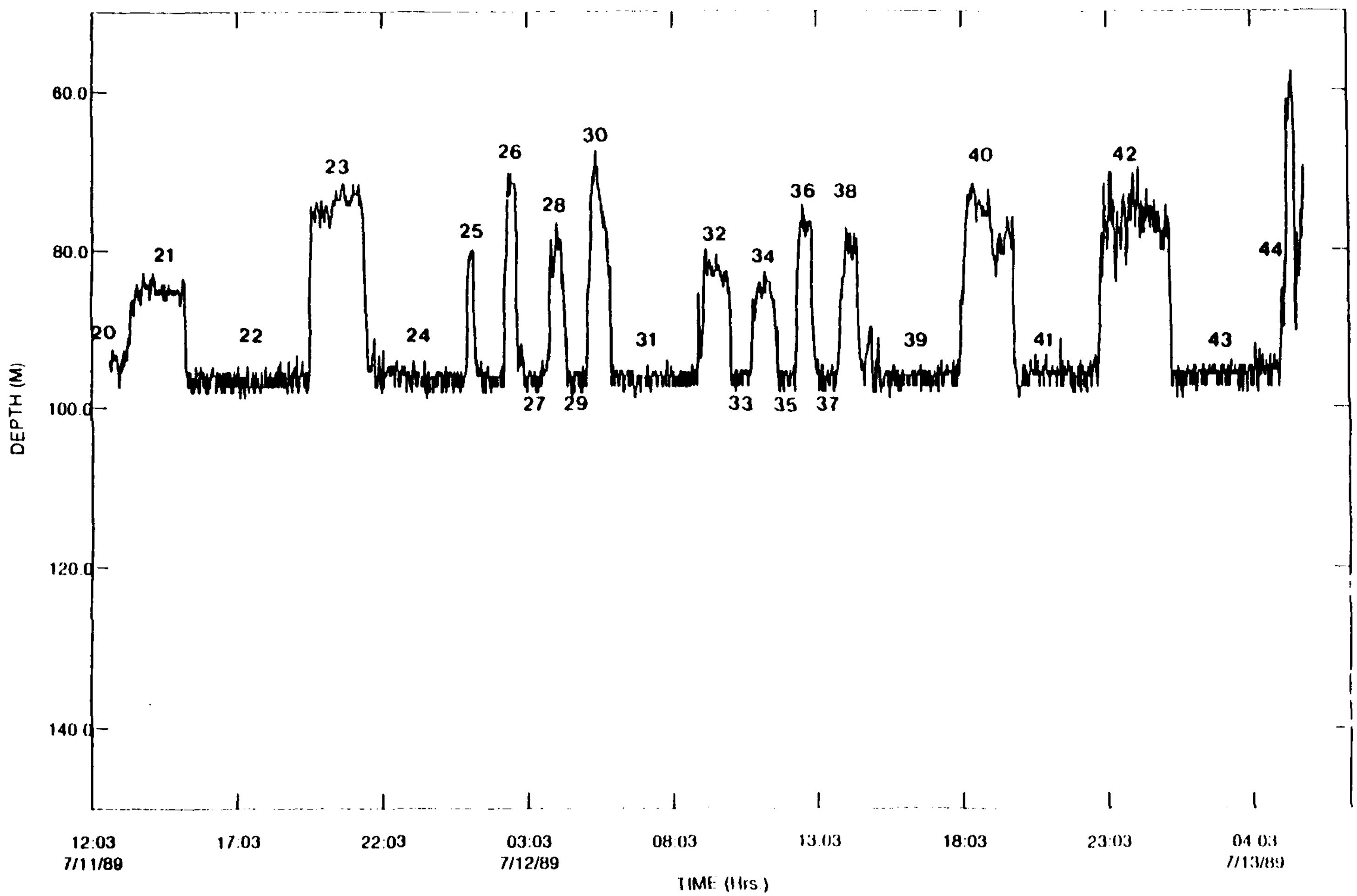


Figure 8 (d).

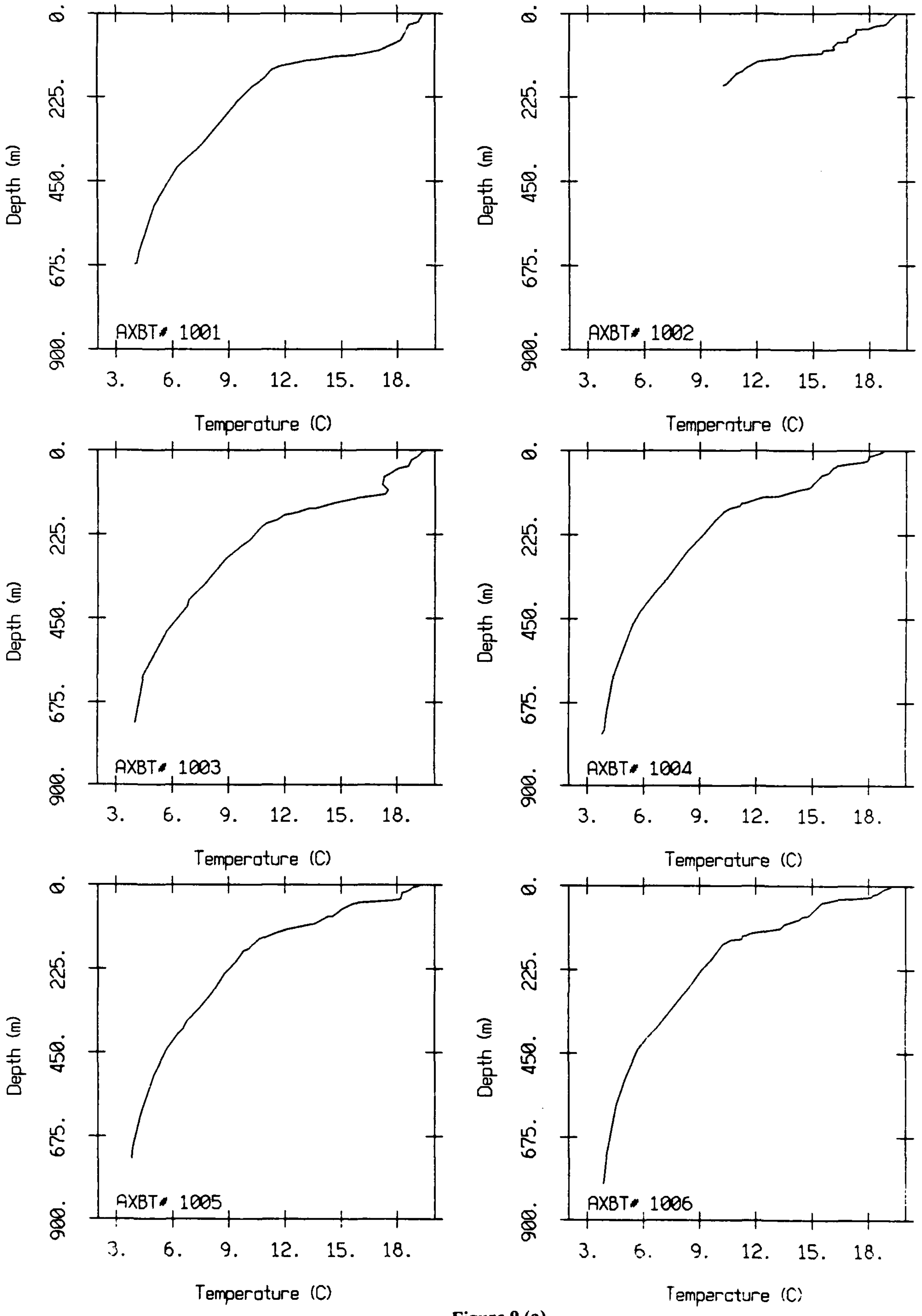

AXBT# 1001
AXBT# 1002
AXBT# 1003
AXBT# 1004
AXBT# 1005
AXBT# 1006
Depth (m)
0.
225.
450.
675.
900.
Temperature (C)
3.
6.
9.
12.
15.
18.

Figure 9 (a).

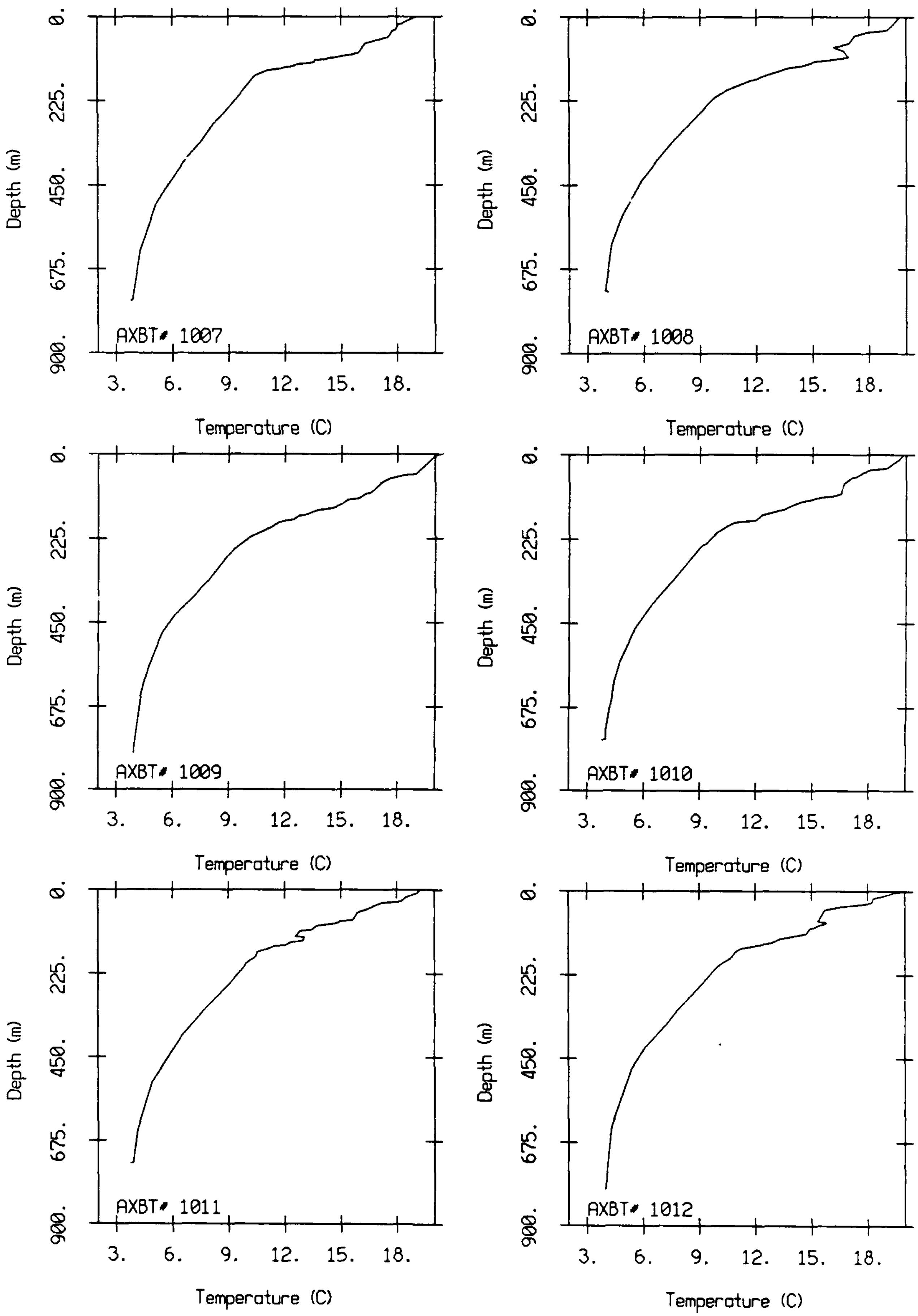


Figure 9 (a). (cont.)

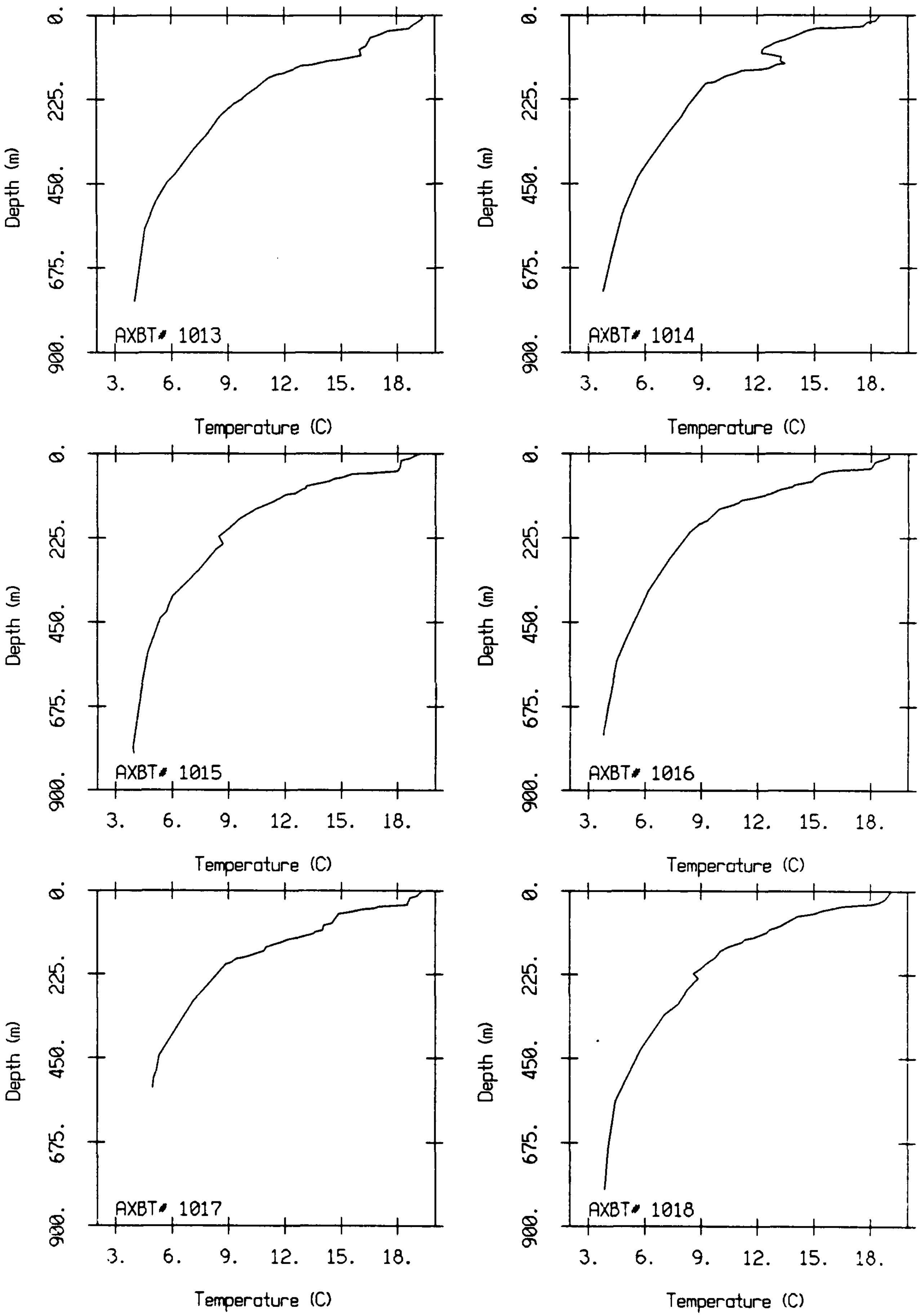


Figure 9 (a). (cont.)

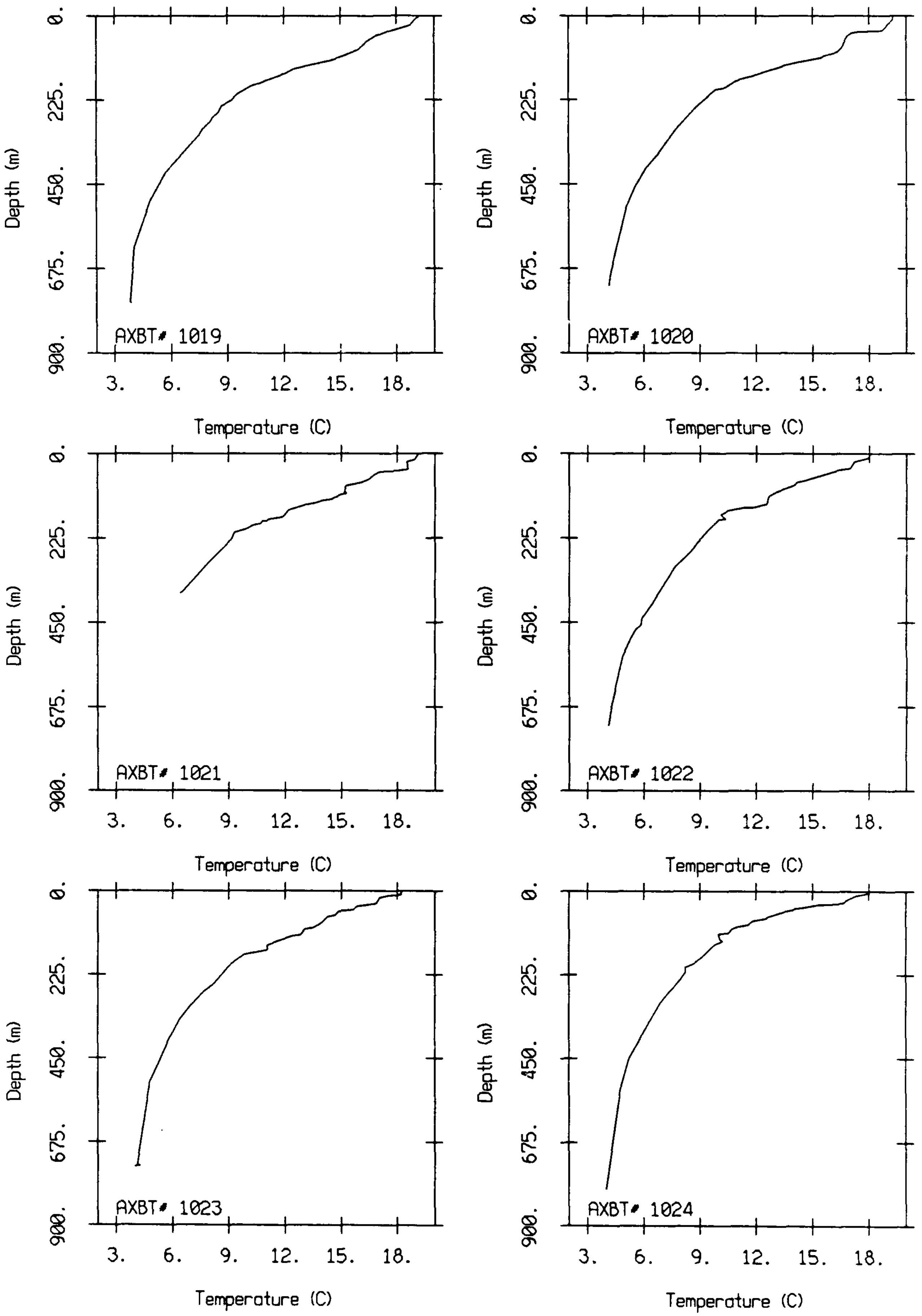


Figure 9 (a). (cont.)

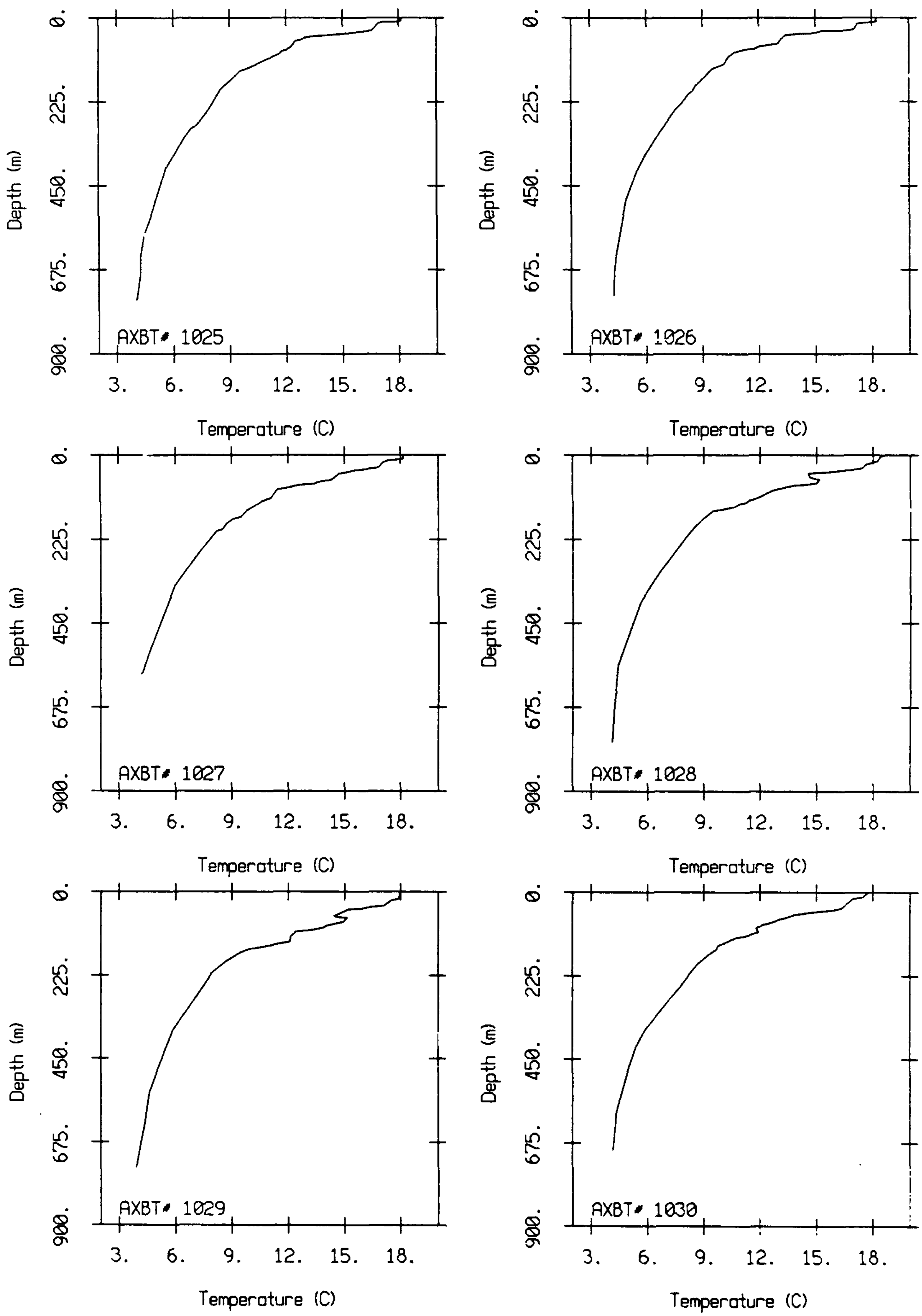


Figure 9 (a). (cont.)

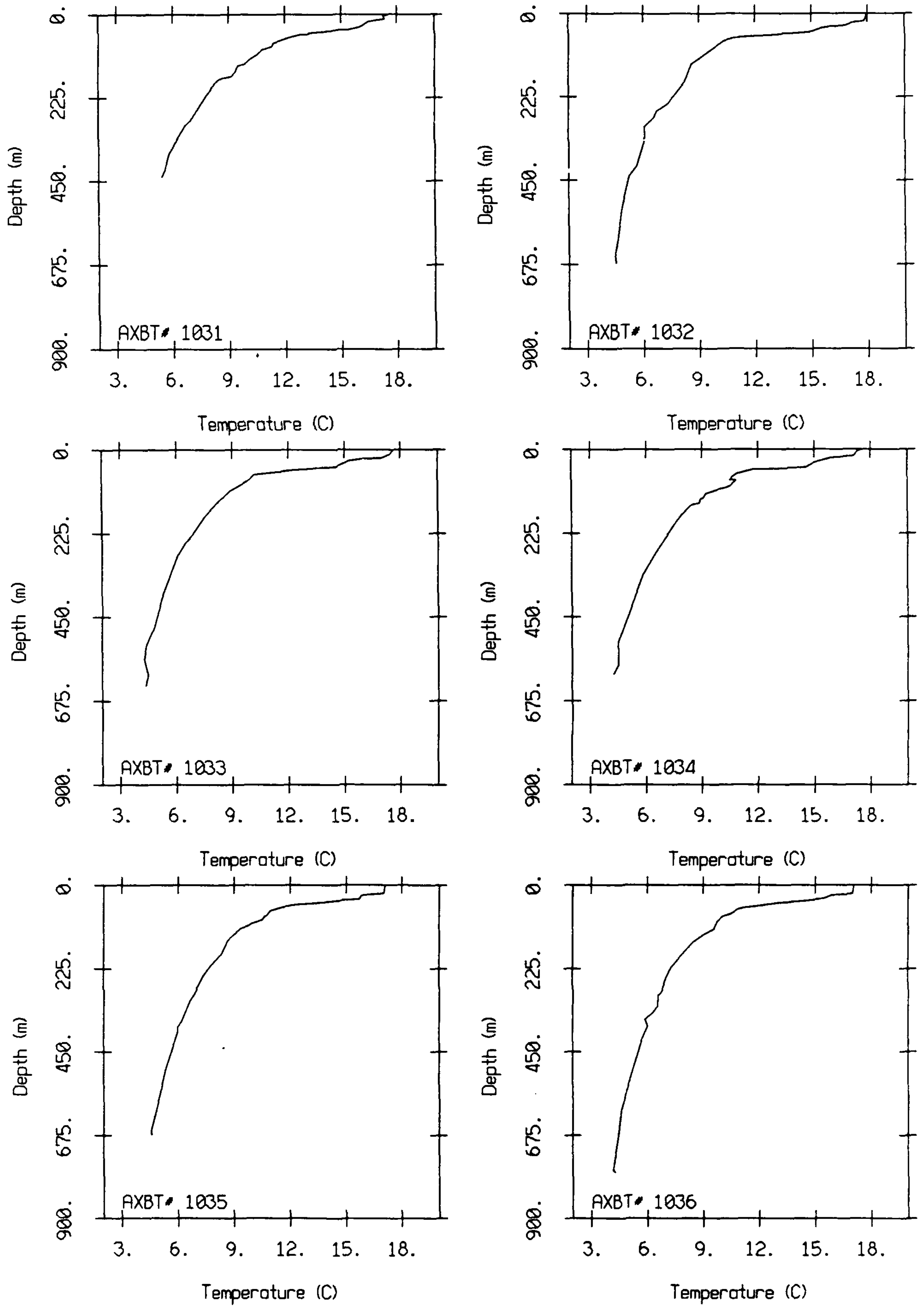


Figure 9 (a). (cont.)

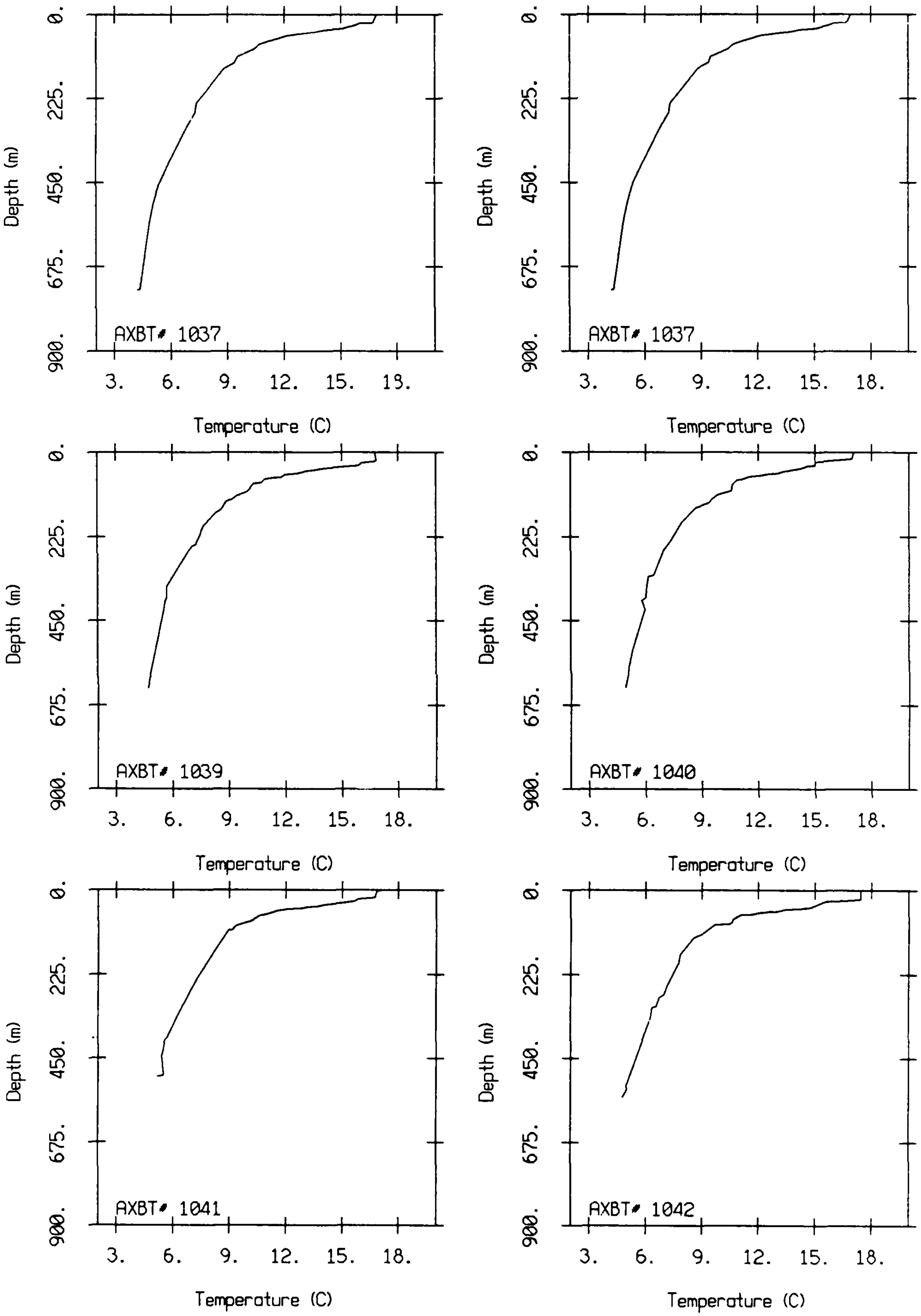


Figure 9 (a). (cont.)

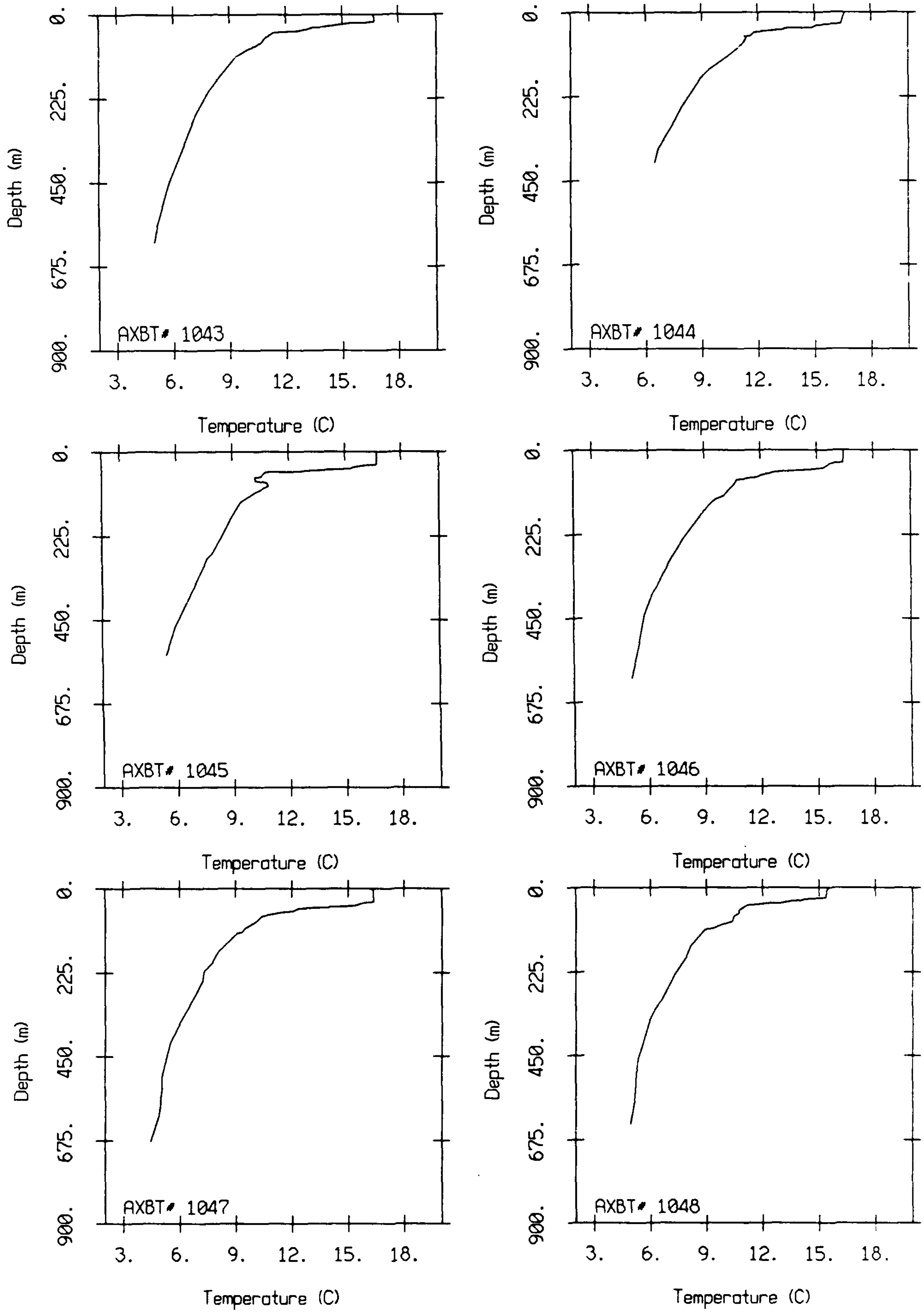


Figure 9 (a). (cont.)

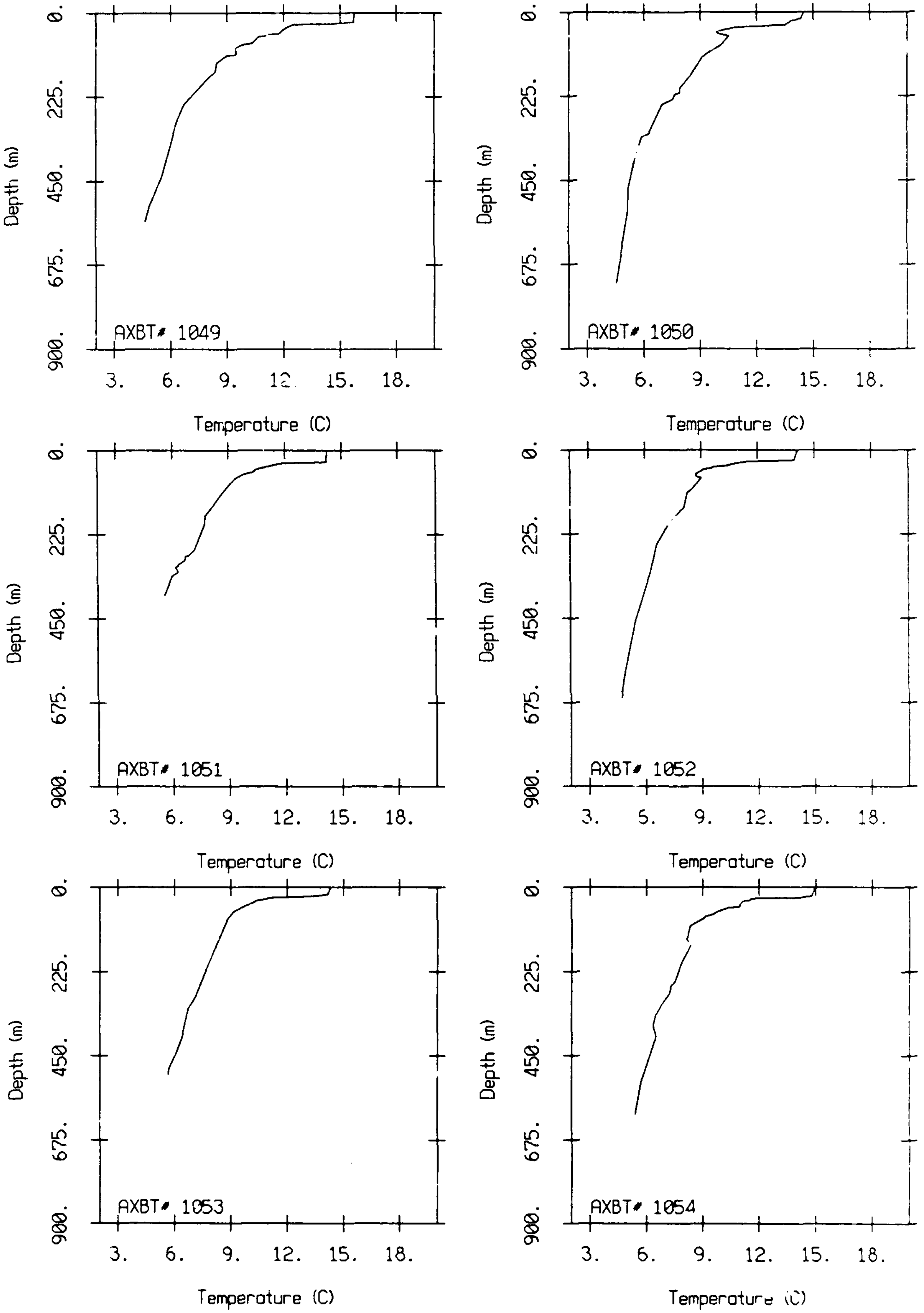


Figure 9 (a). (cont.)

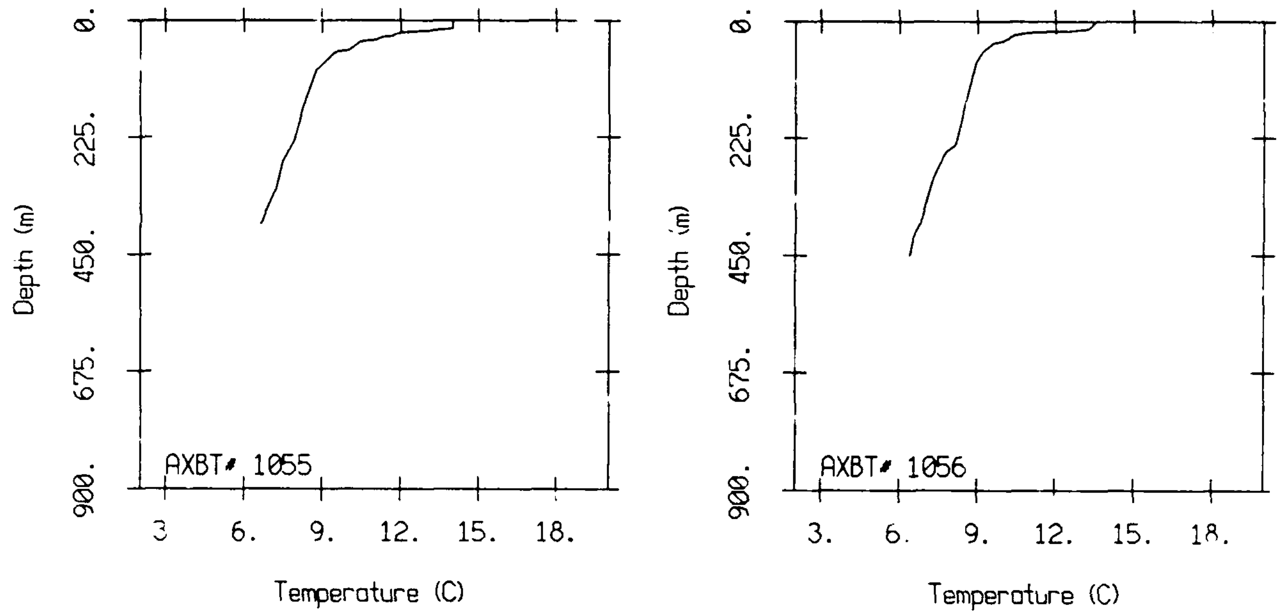


Figure 9 (a). (cont.)

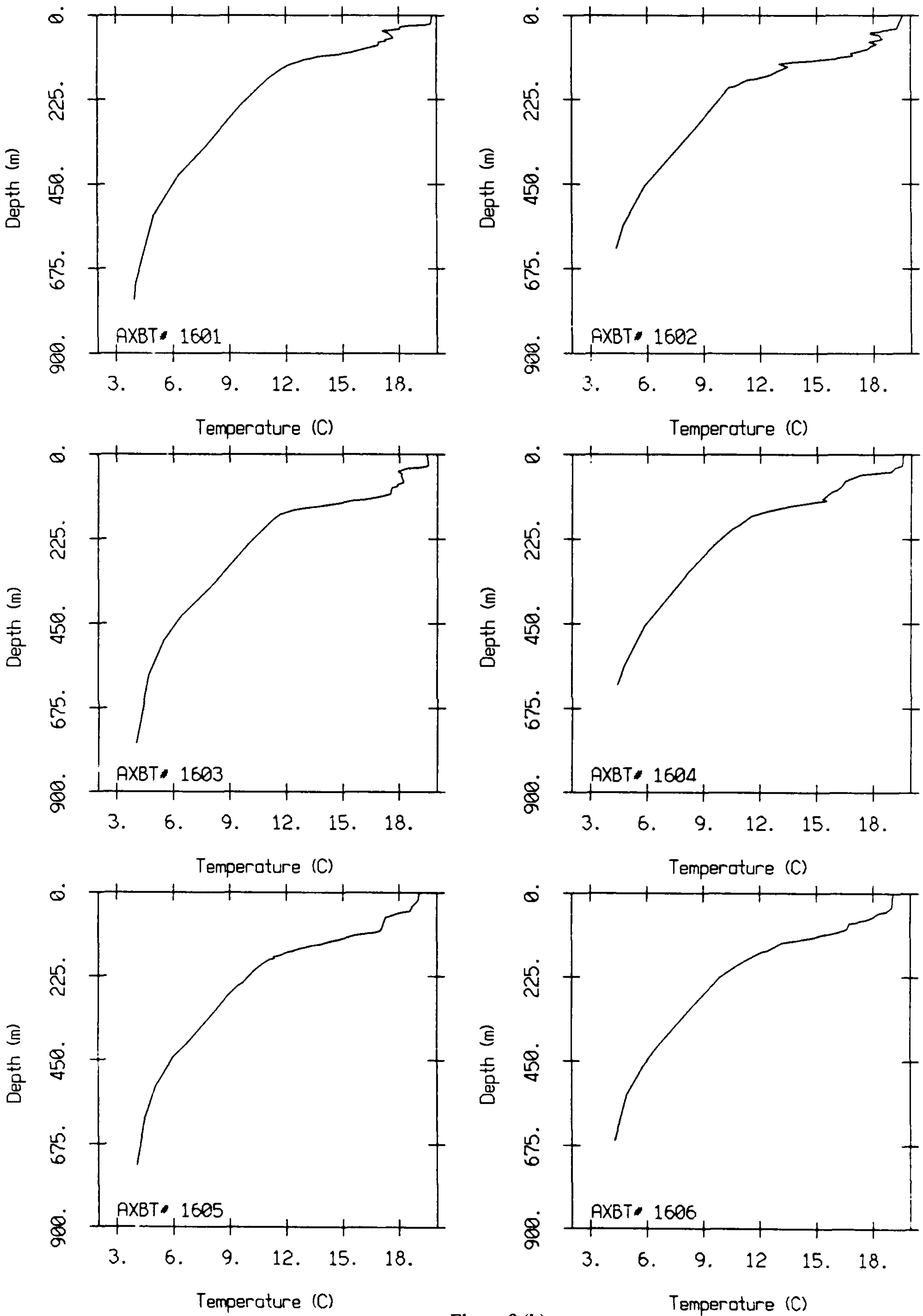

AXBT# 1601
AXBT# 1602
AXBT# 1603
AXBT# 1604
AXBT# 1605
AXBT# 1606
Depth (m)
0.
225.
450.
675.
900.
3.
6.
9.
12.
15.
18.
Temperature (C)

Figure 9 (b).

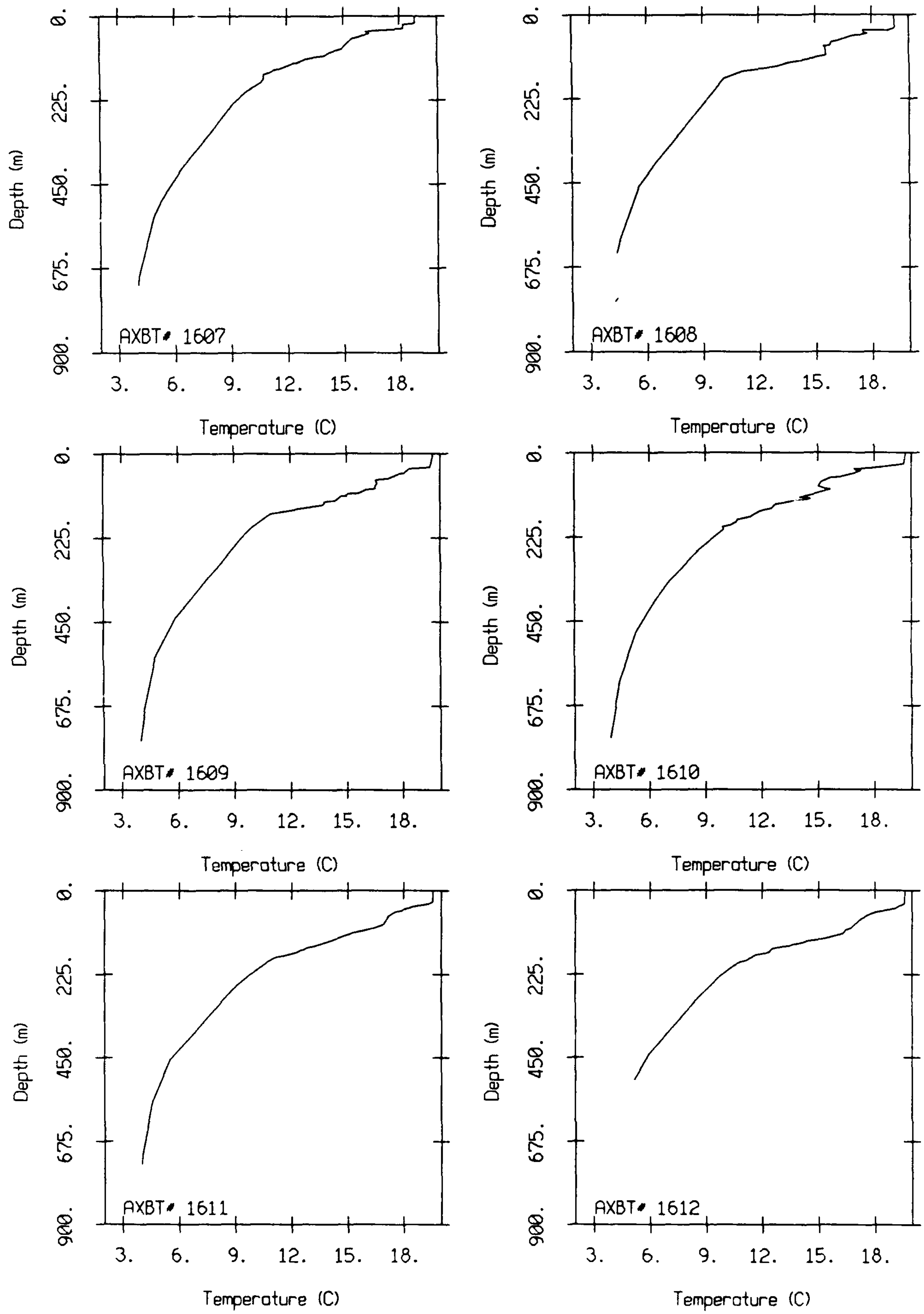


Figure 9 (b). (cont.)

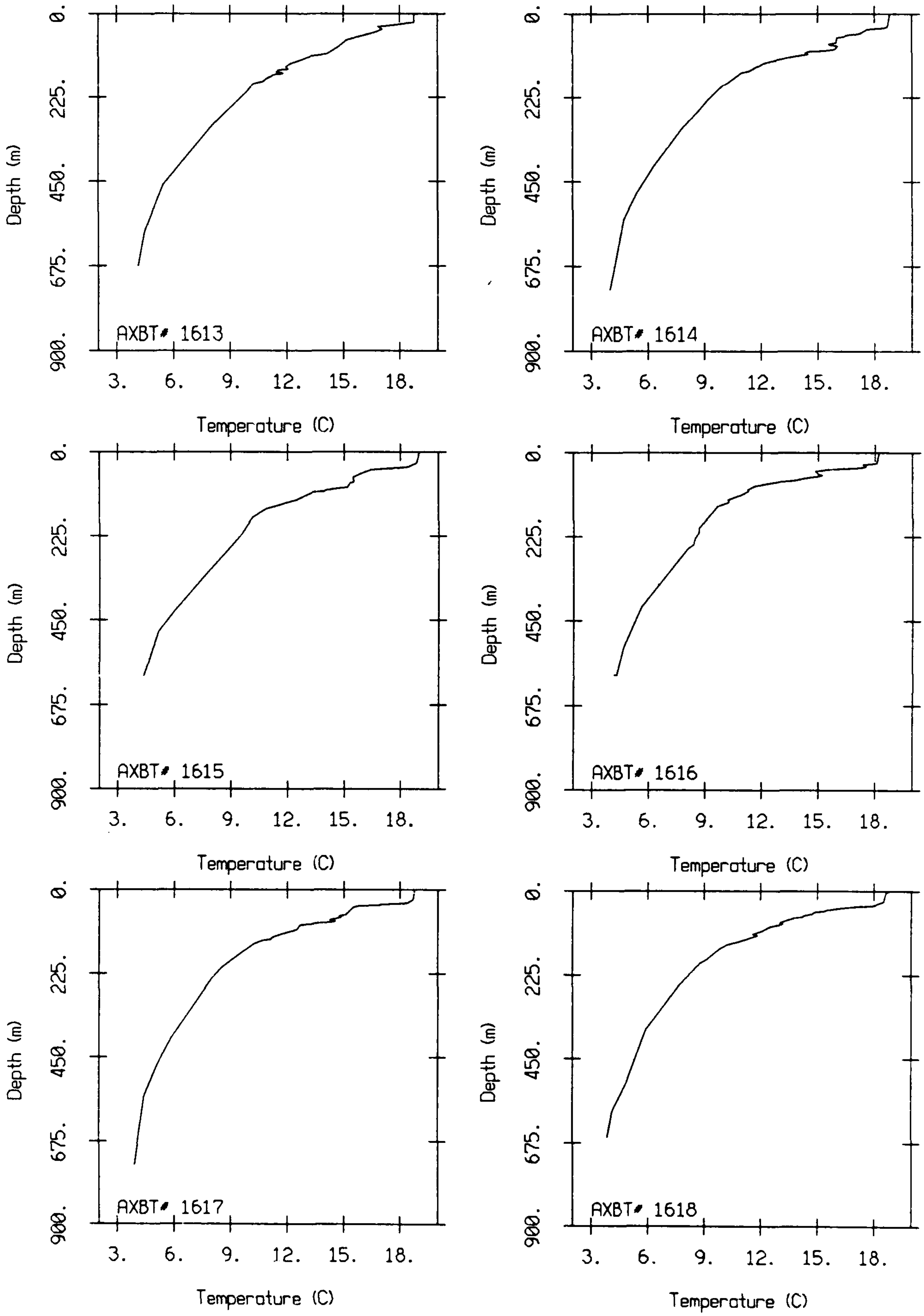


Figure 9 (b). (cont.)

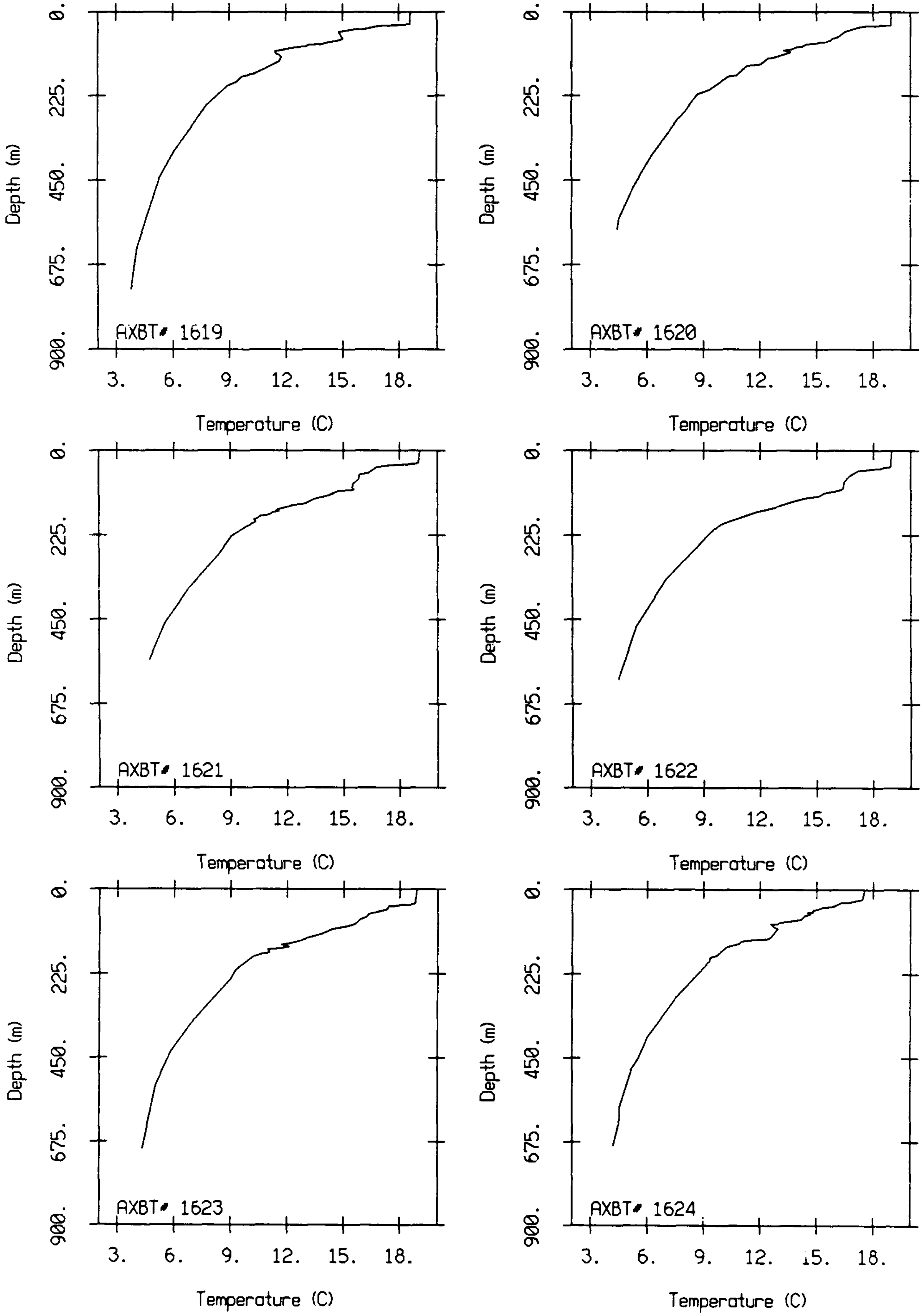


Figure 9 (b). (cont.)

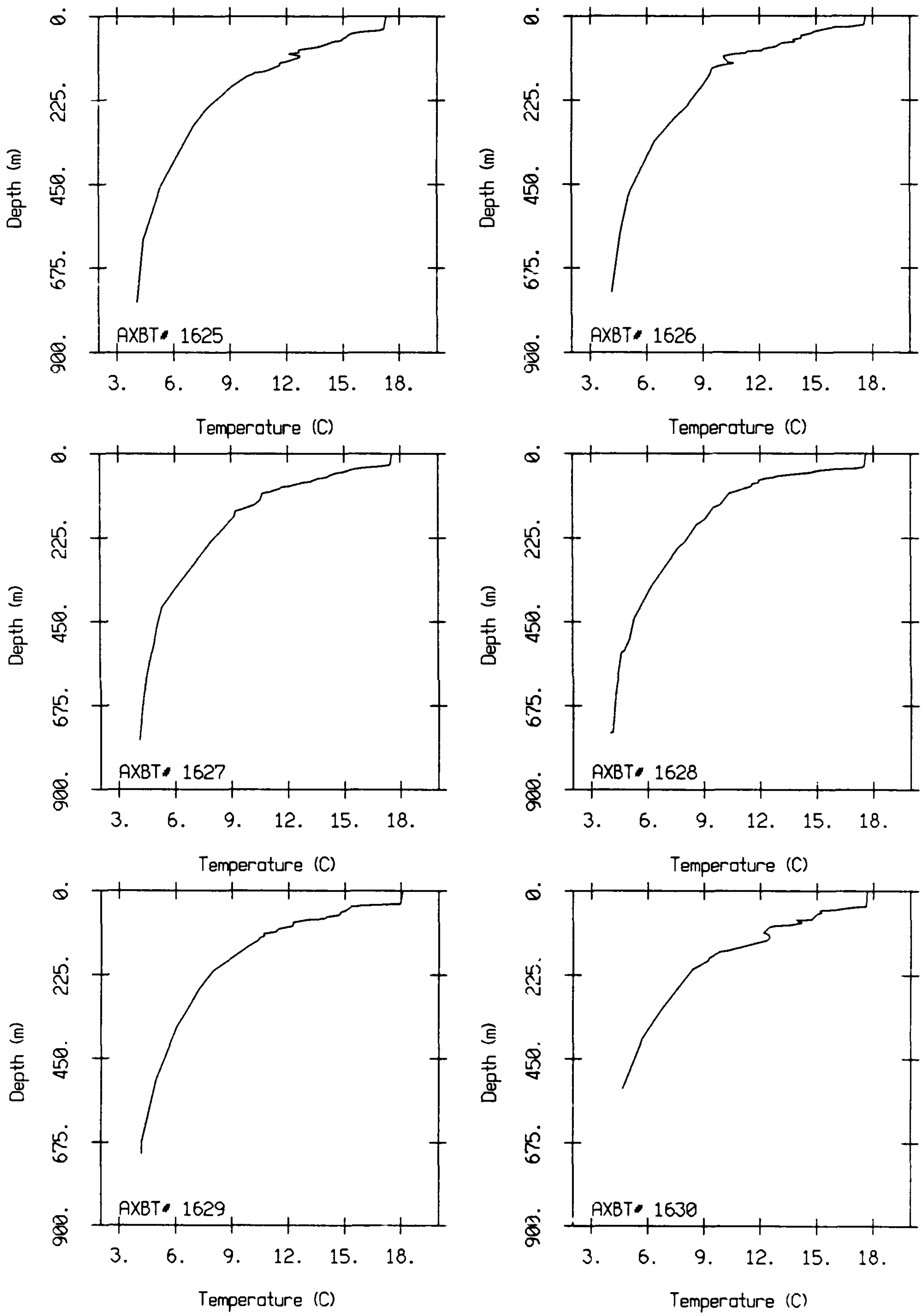


Figure 9 (b). (cont.)

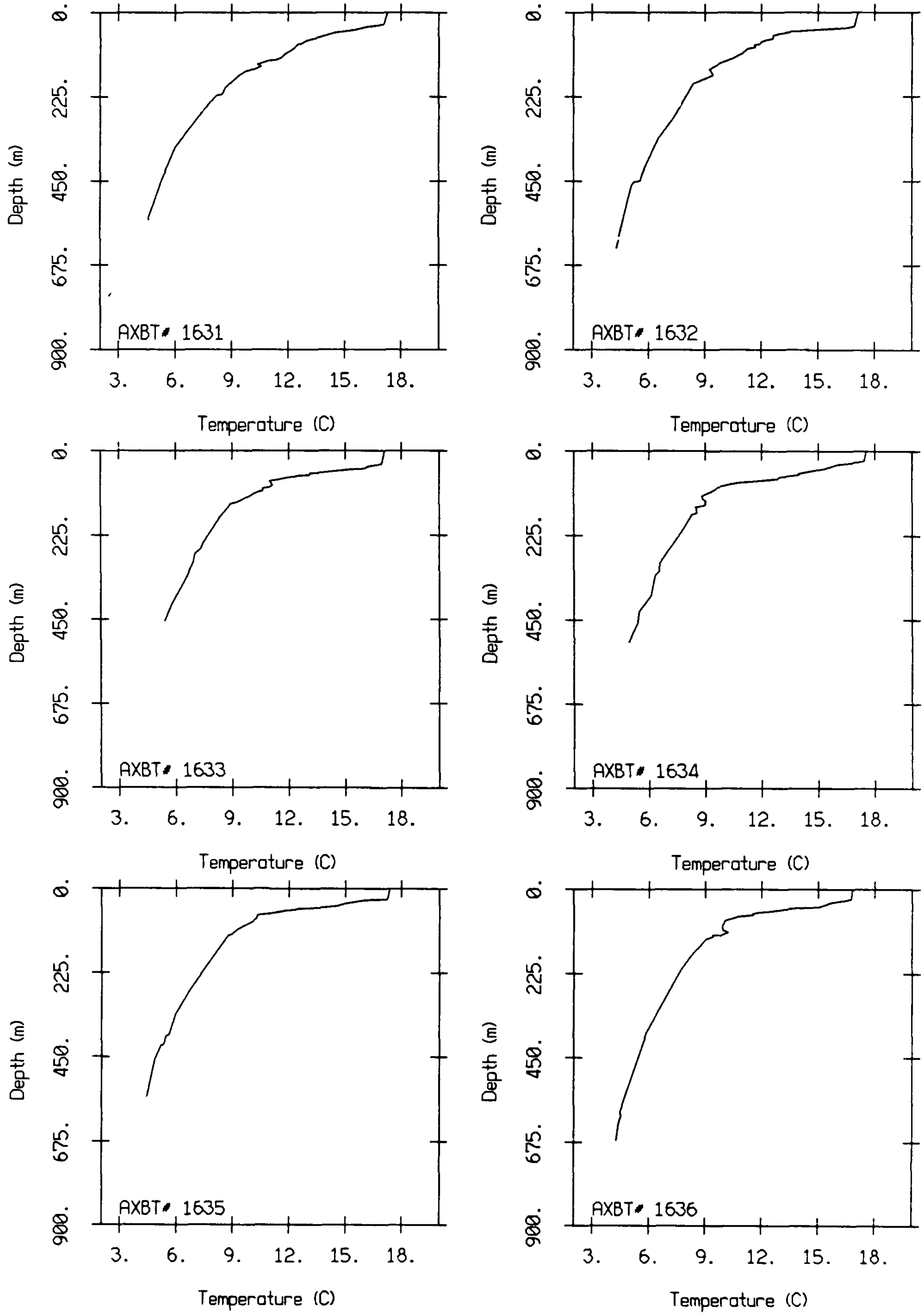


Figure 9 (b). (cont.)

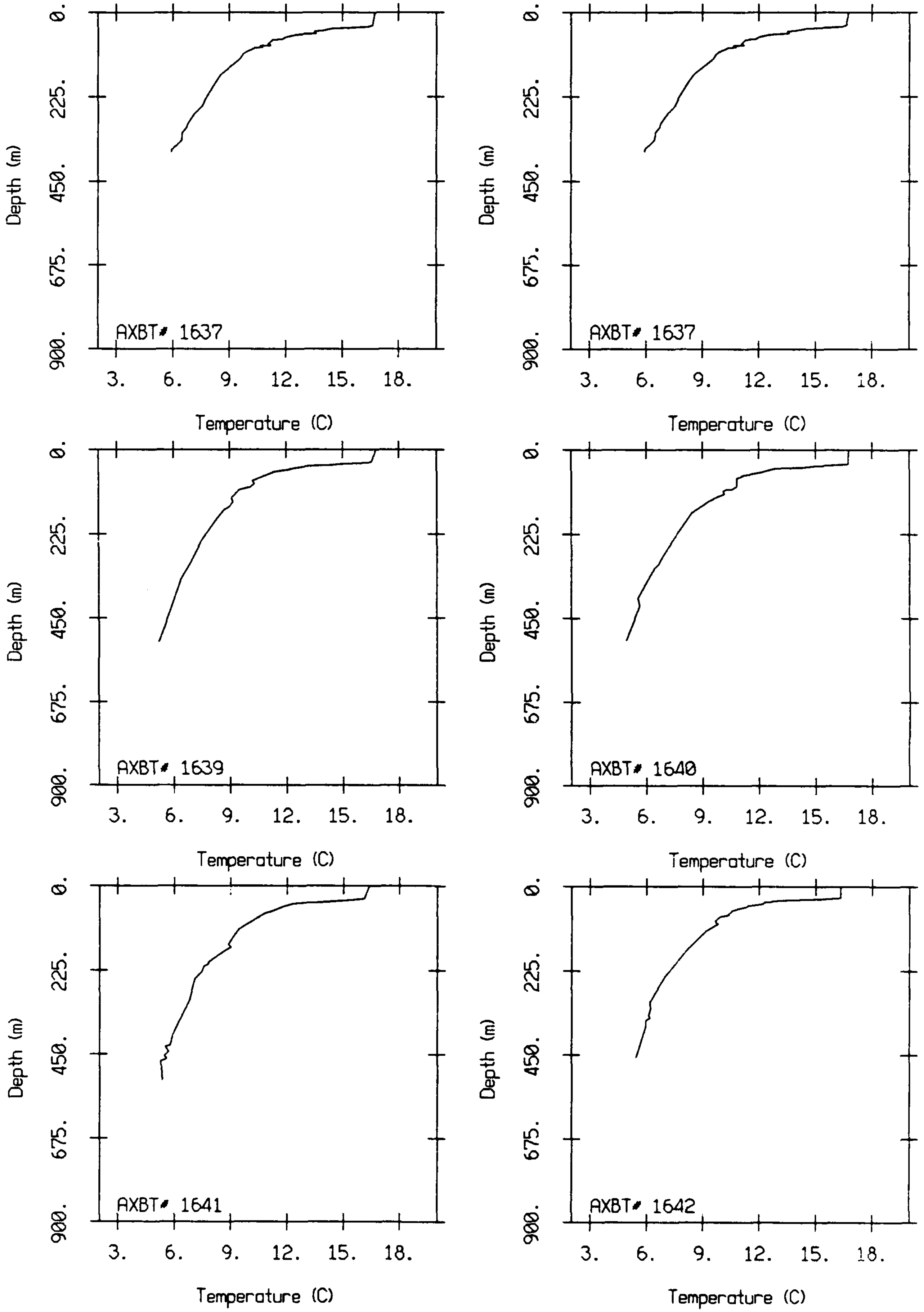


Figure 9 (b). (cont.)

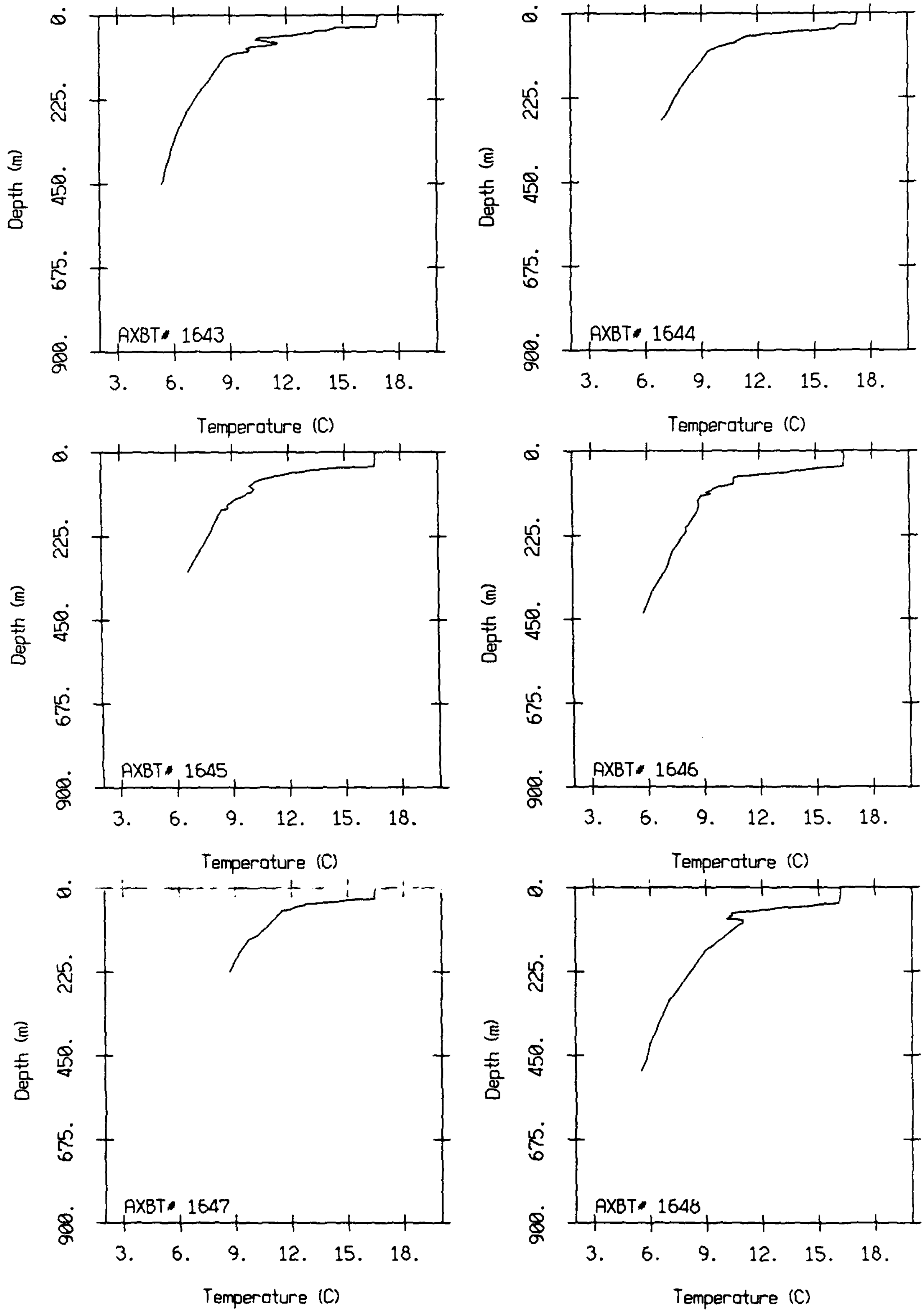


Figure 9 (b). (cont.)

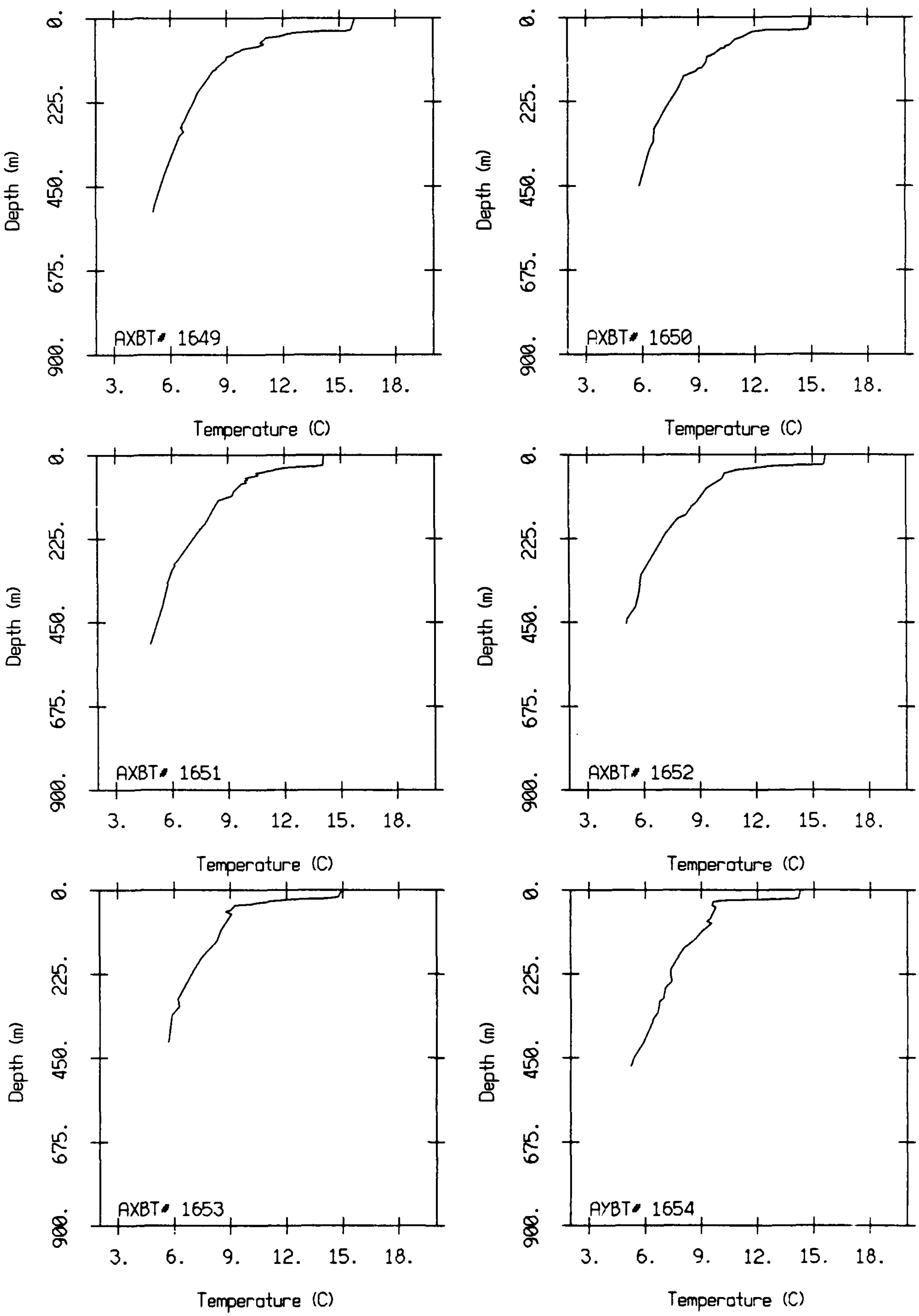


Figure 9 (b). (cont.)

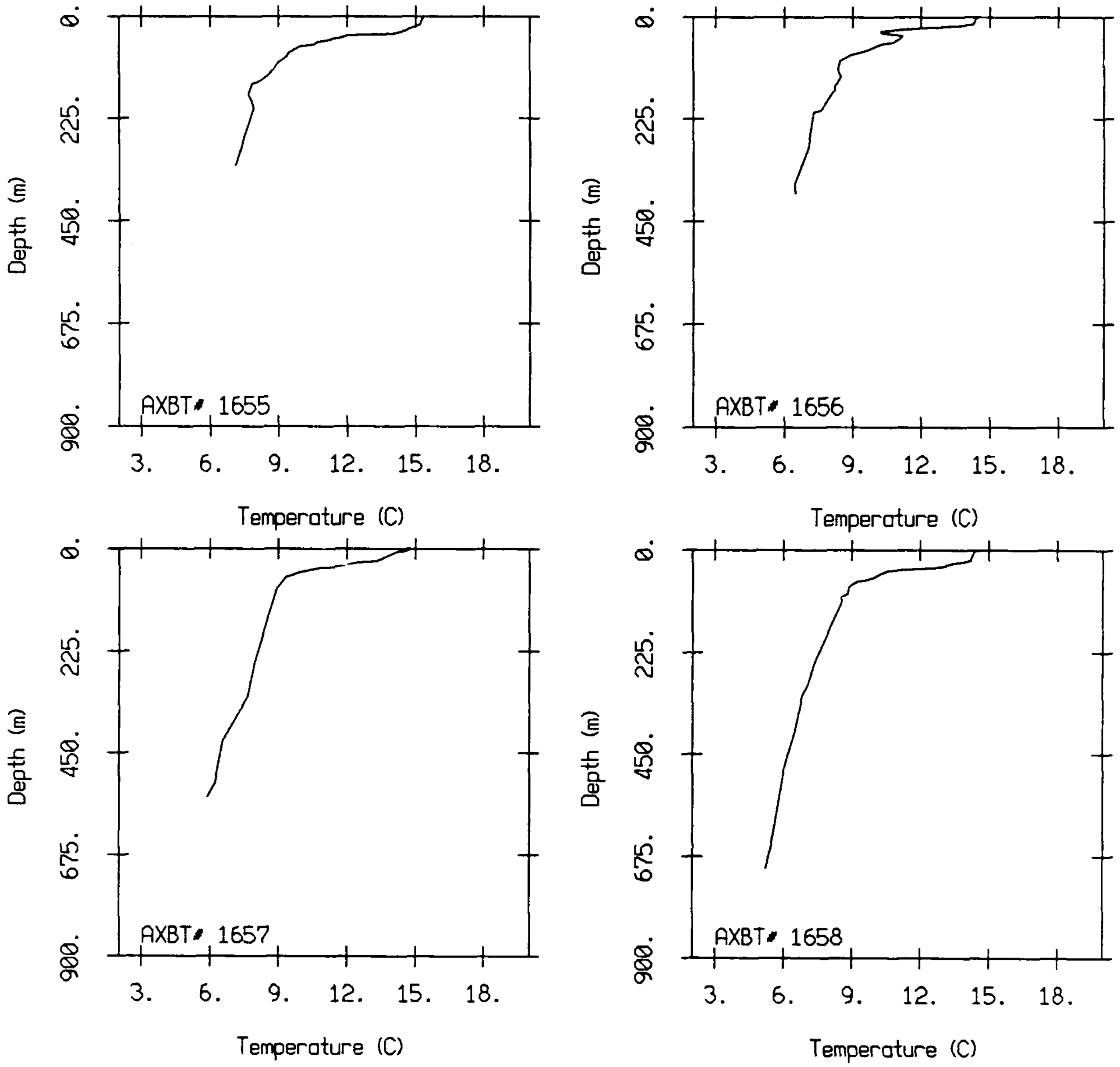
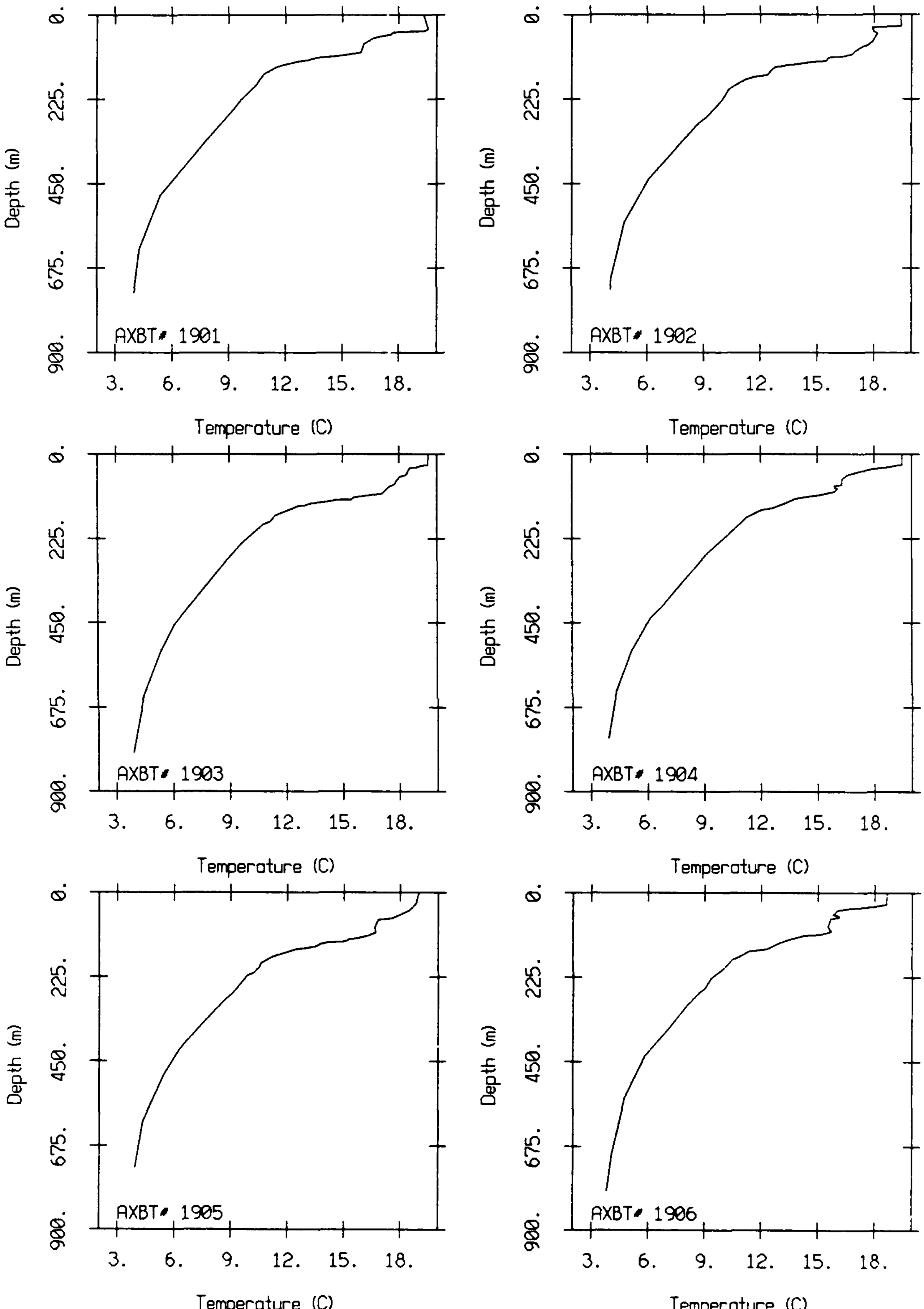


Figure 9 (b). (cont.)



AXBT# 1901
AXBT# 1902
AXBT# 1903
AXBT# 1904
AXBT# 1905
AXBT# 1906
Depth (m)
0.
225.
450.
675.
900.
Temperature (C)
3.
6.
9.
12.
15.
18.

Figure 9 (c).

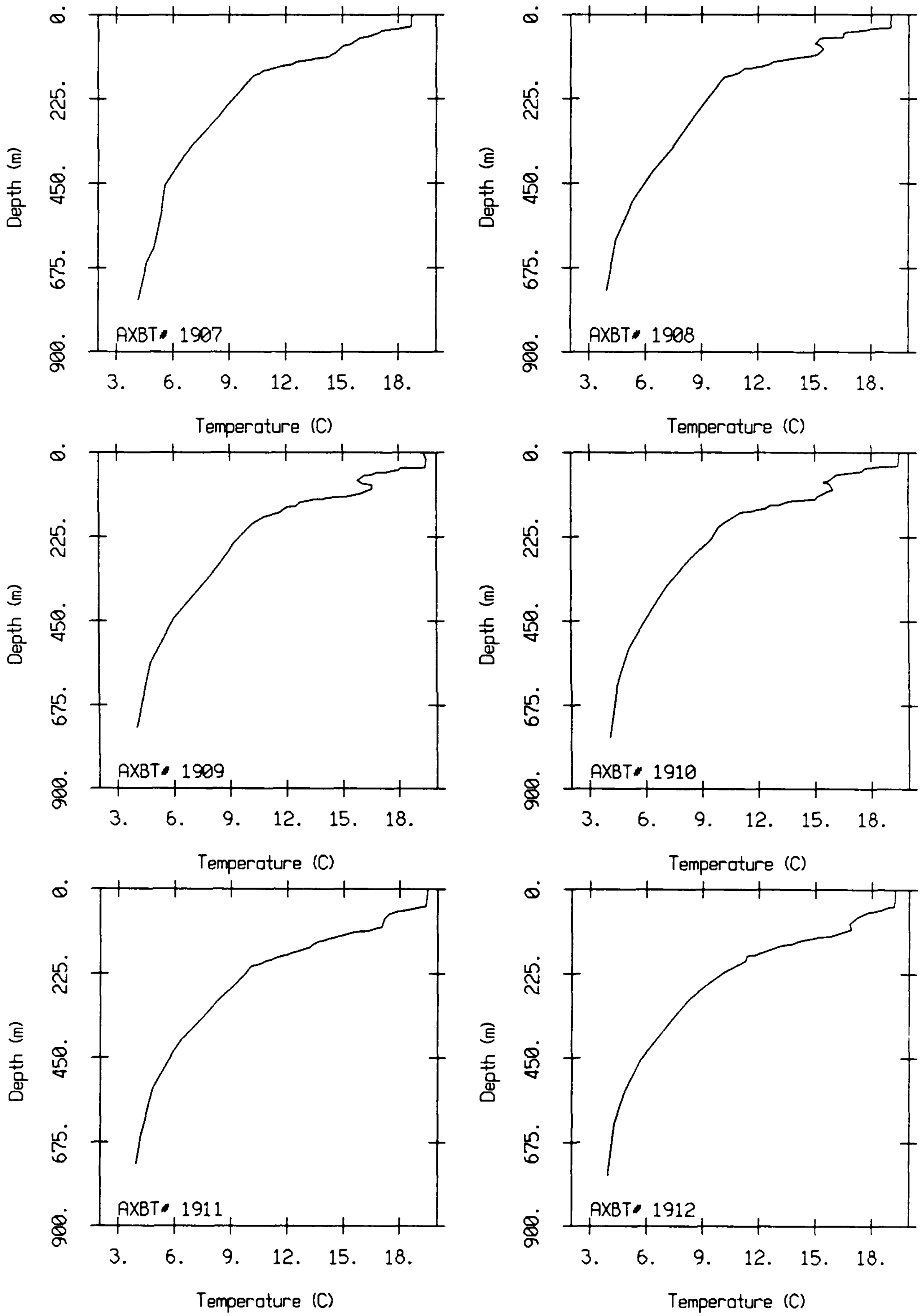


Figure 9 (c). (cont.)

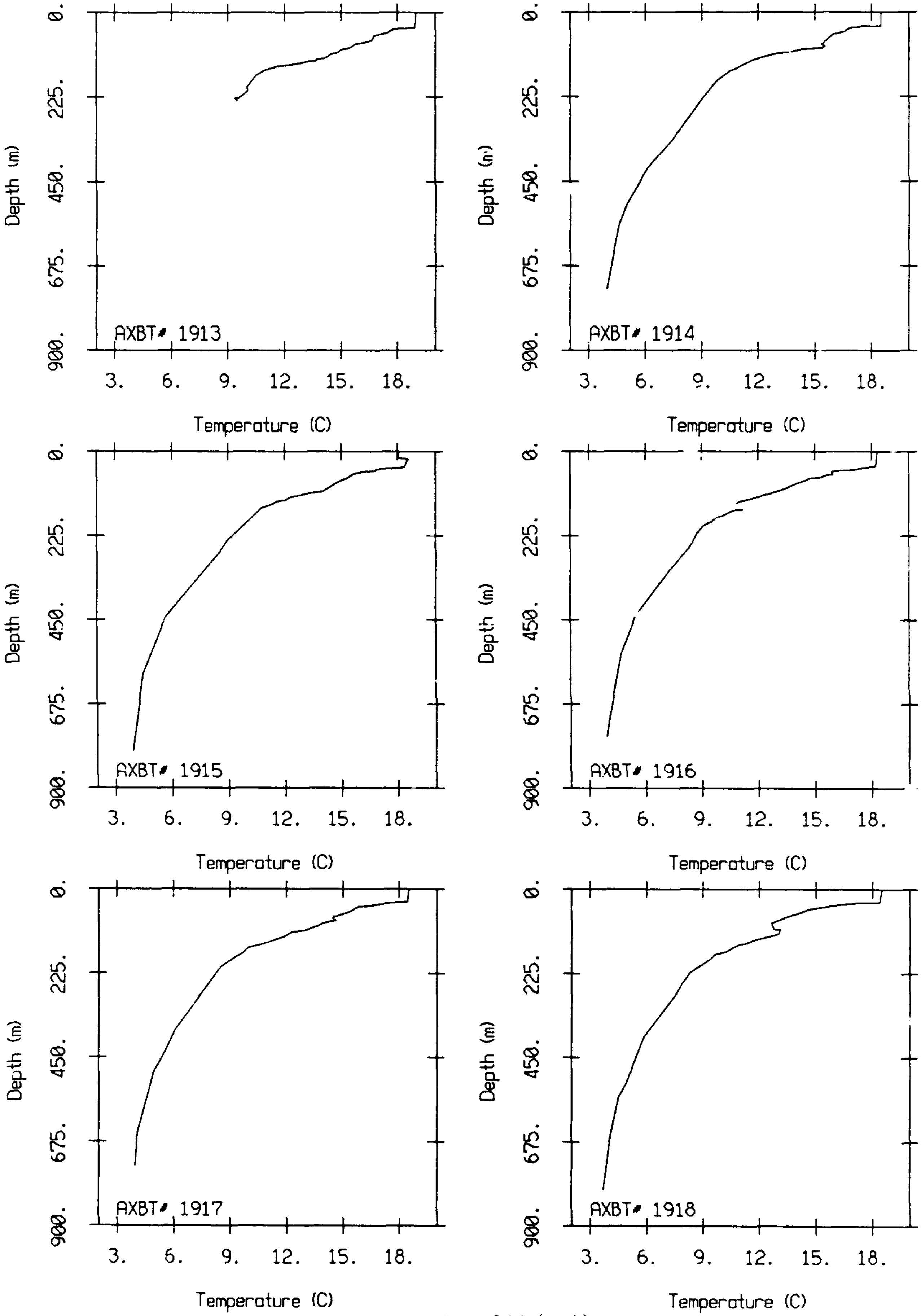


Figure 9 (c). (cont.)

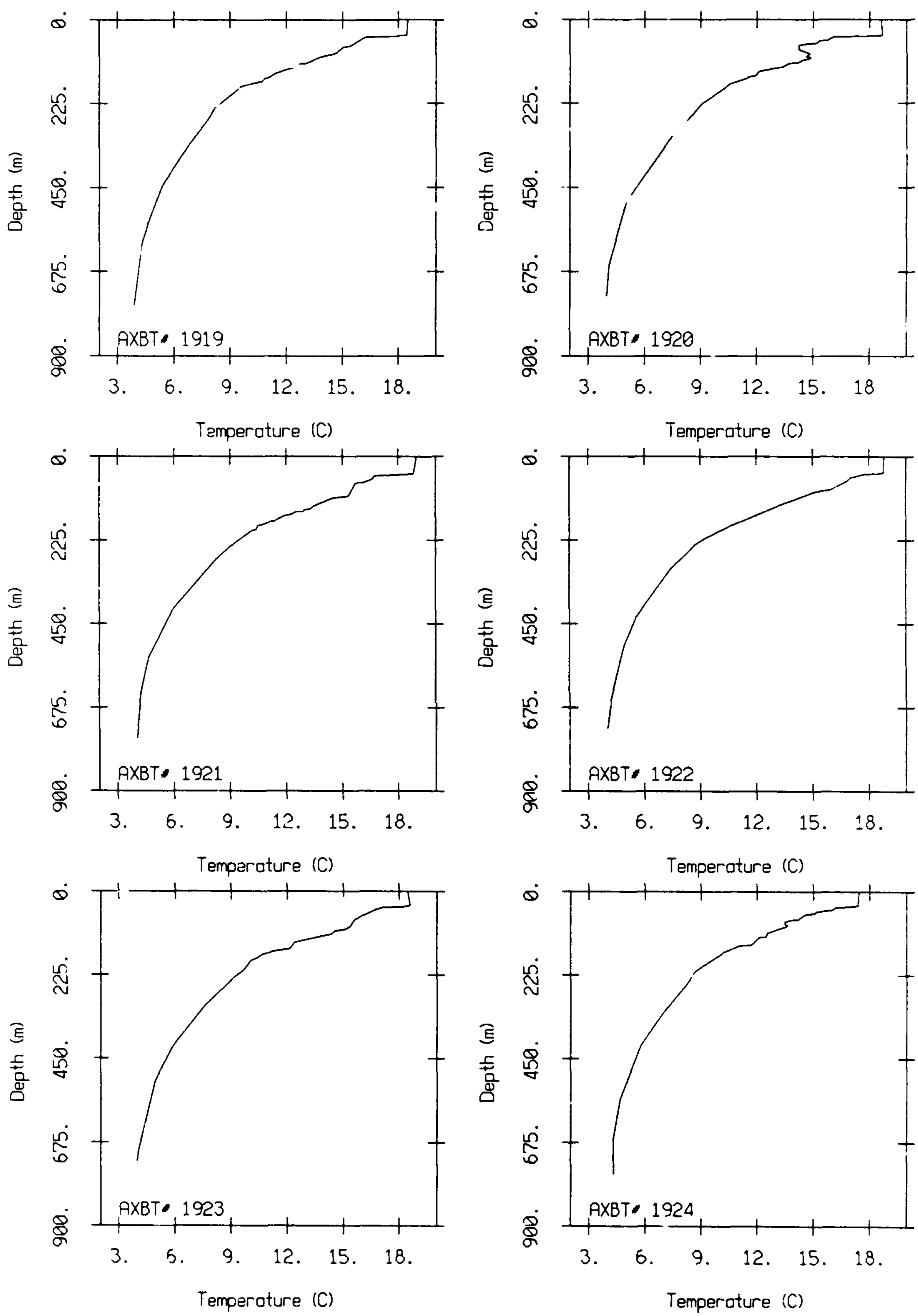


Figure 9 (c). (cont.)

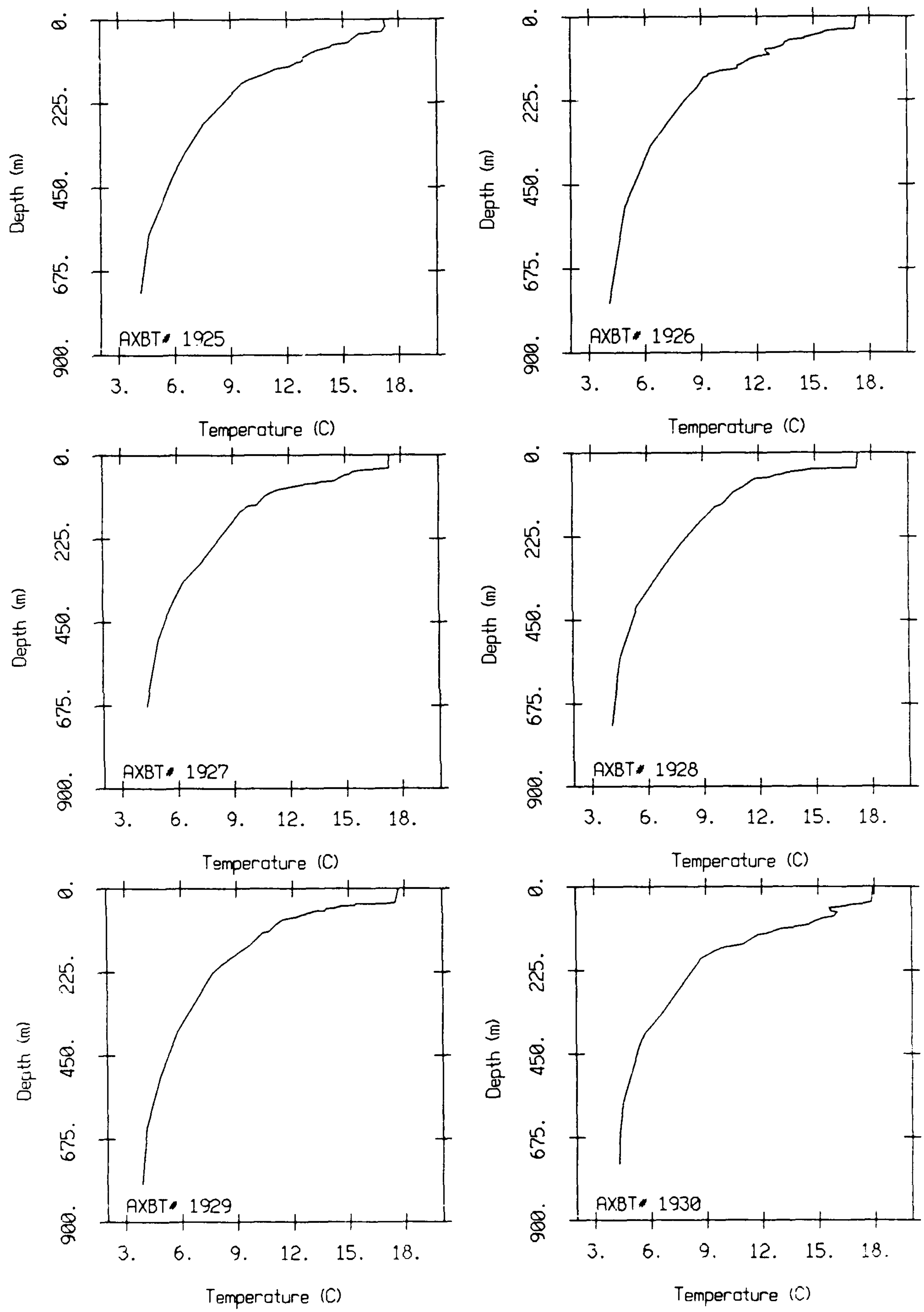


Figure 9 (c). (cont.)

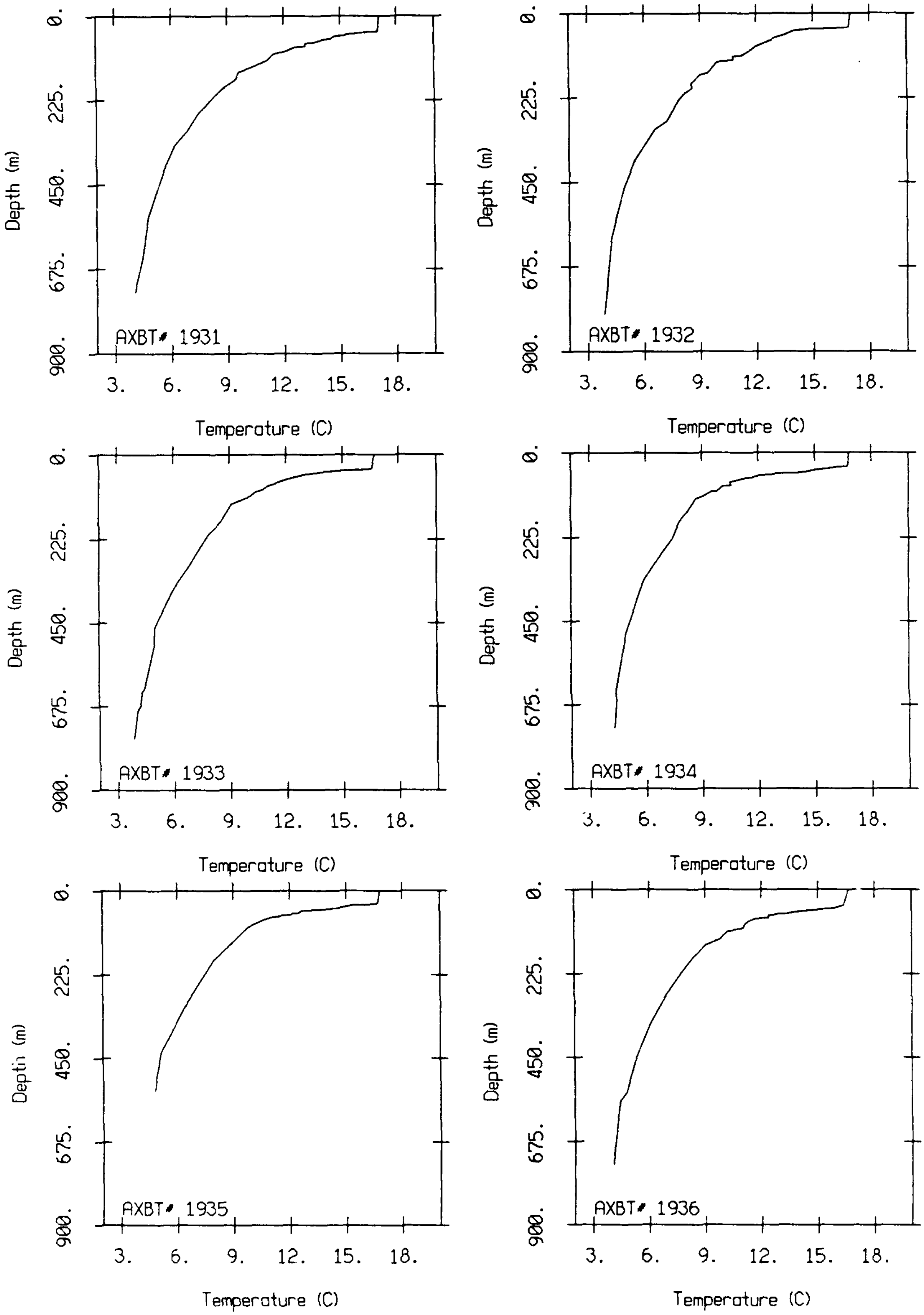


Figure 9 (c). (cont.)

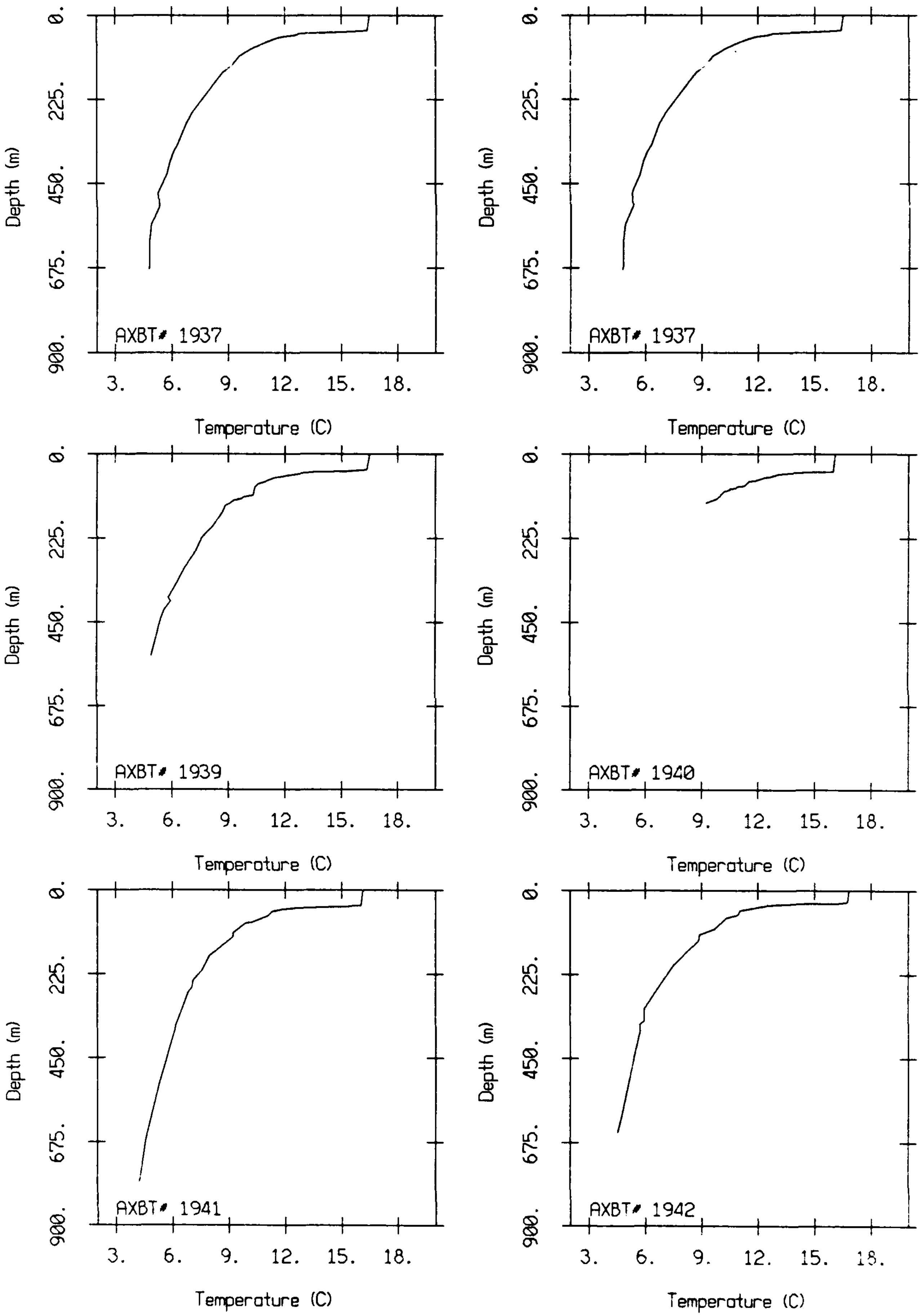


Figure 9 (c). (cont.)

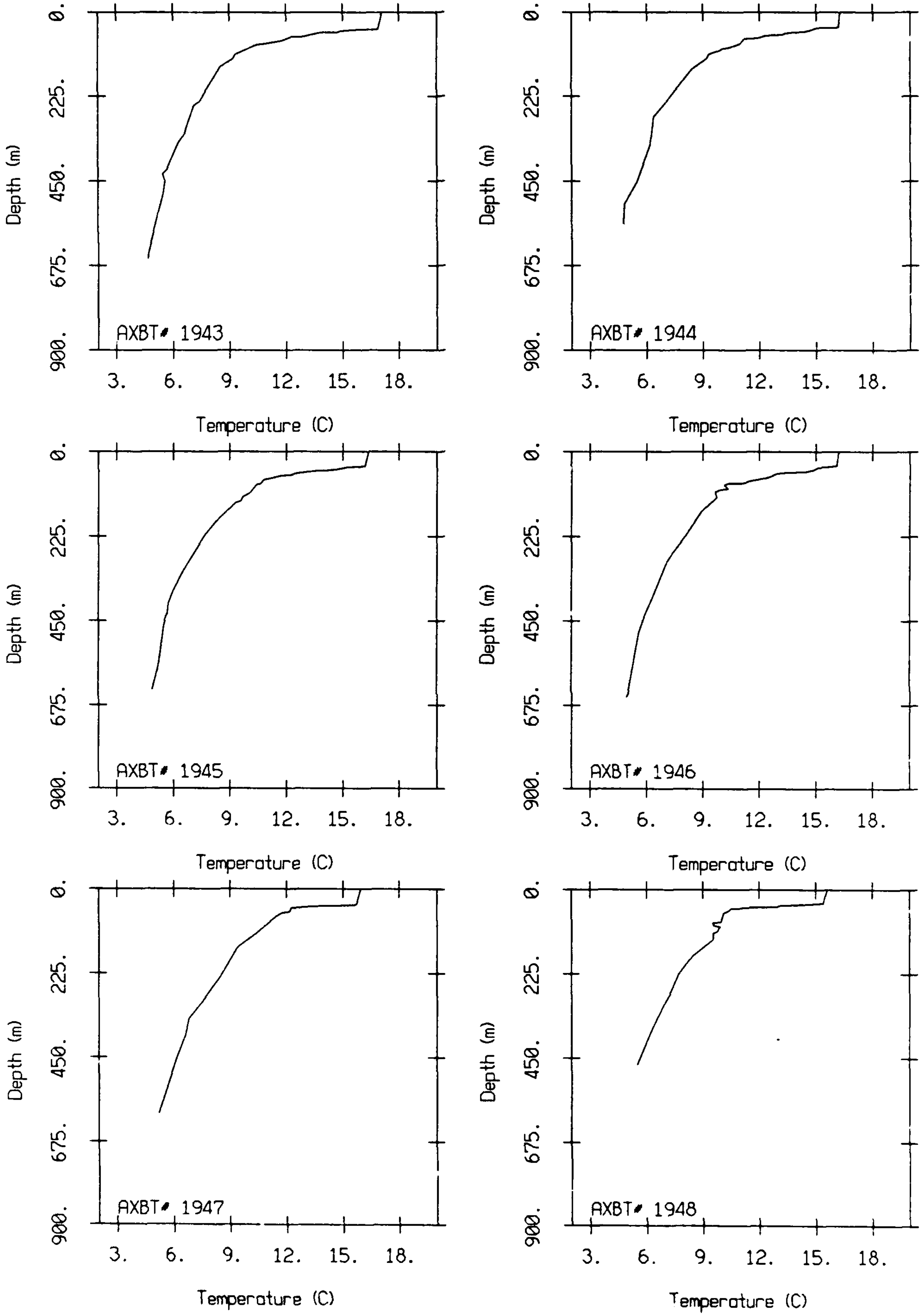


Figure 9 (c). (cont.)

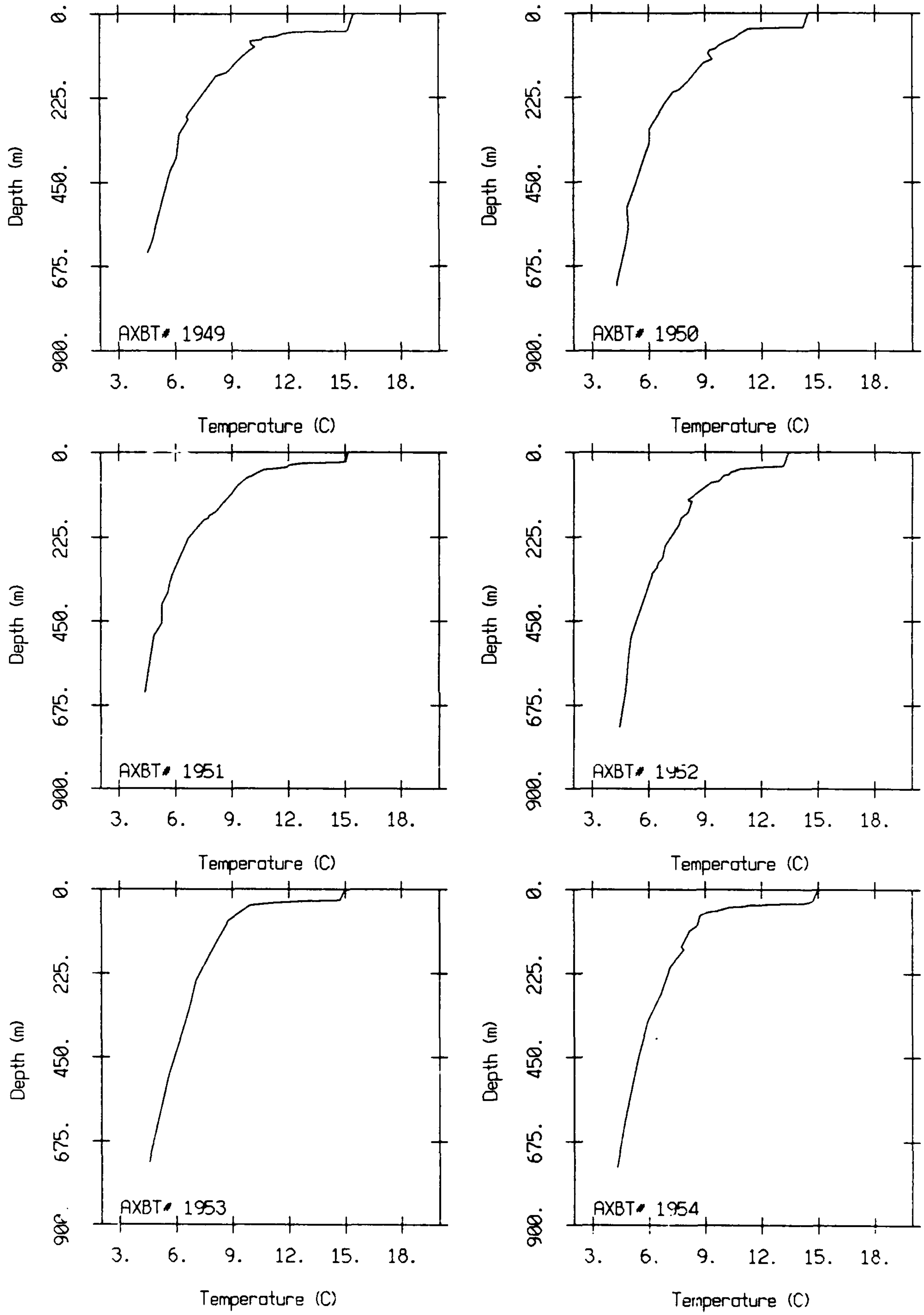


Figure 9 (c). (cont.)

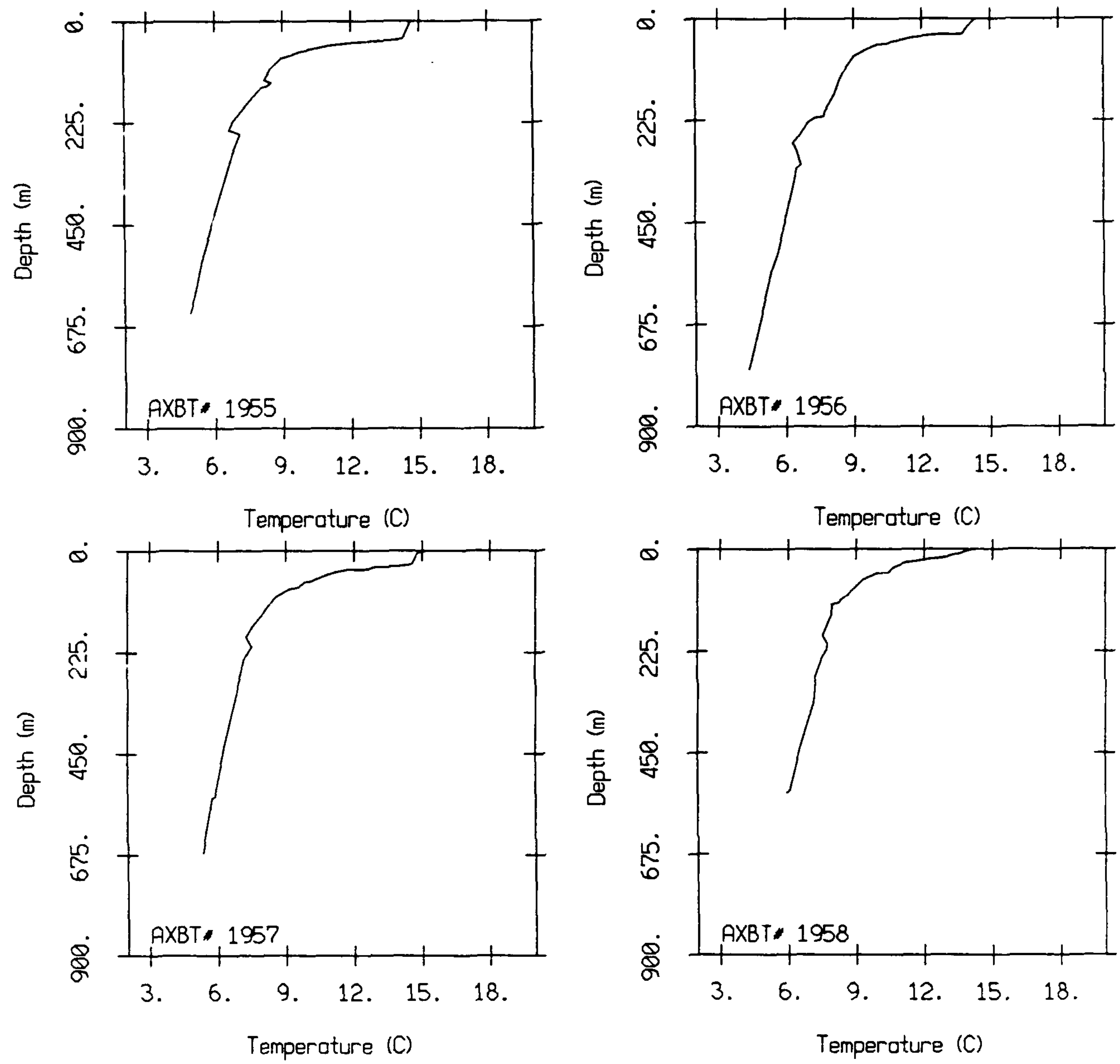


Figure 9 (c). (cont.)

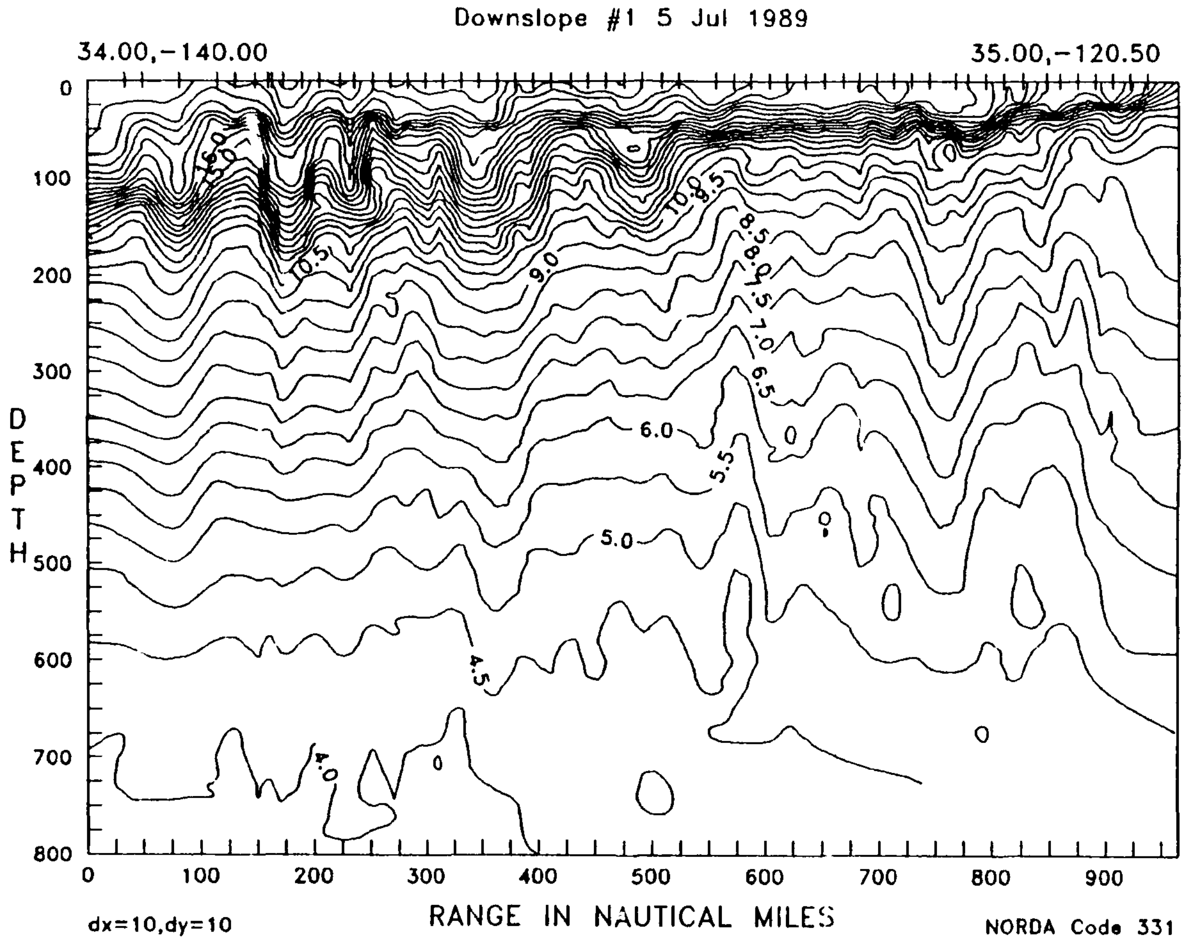

Downslope #1 5 Jul 1989
34.00,-140.00
35.00,-120.50
DEPTH
0
100
200
300
400
500
600
700
800
0
100
200
300
400
500
600
700
800
900
RANGE IN NAUTICAL MILES
dx=10,dy=10
NORDA Code 331
10.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0

Figure 10 (a).

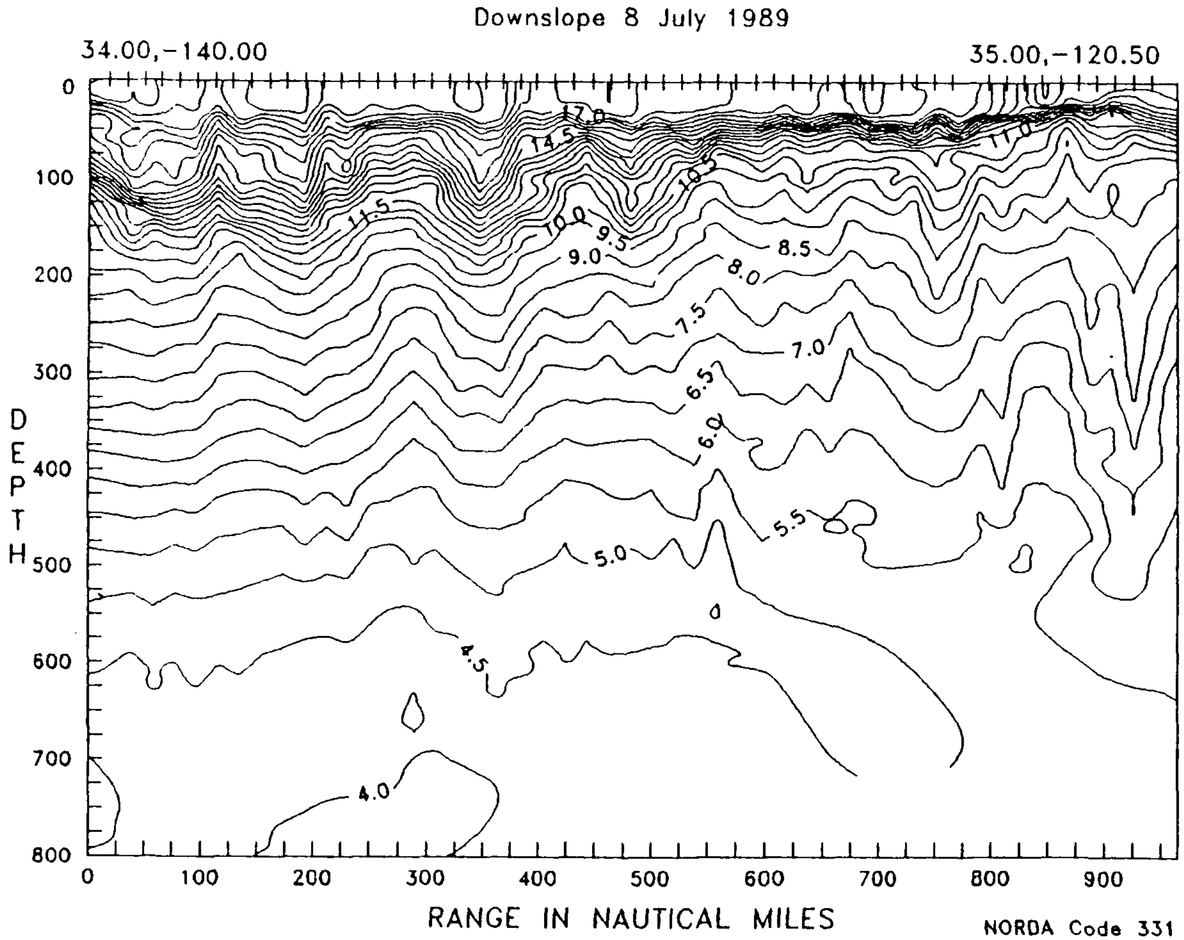
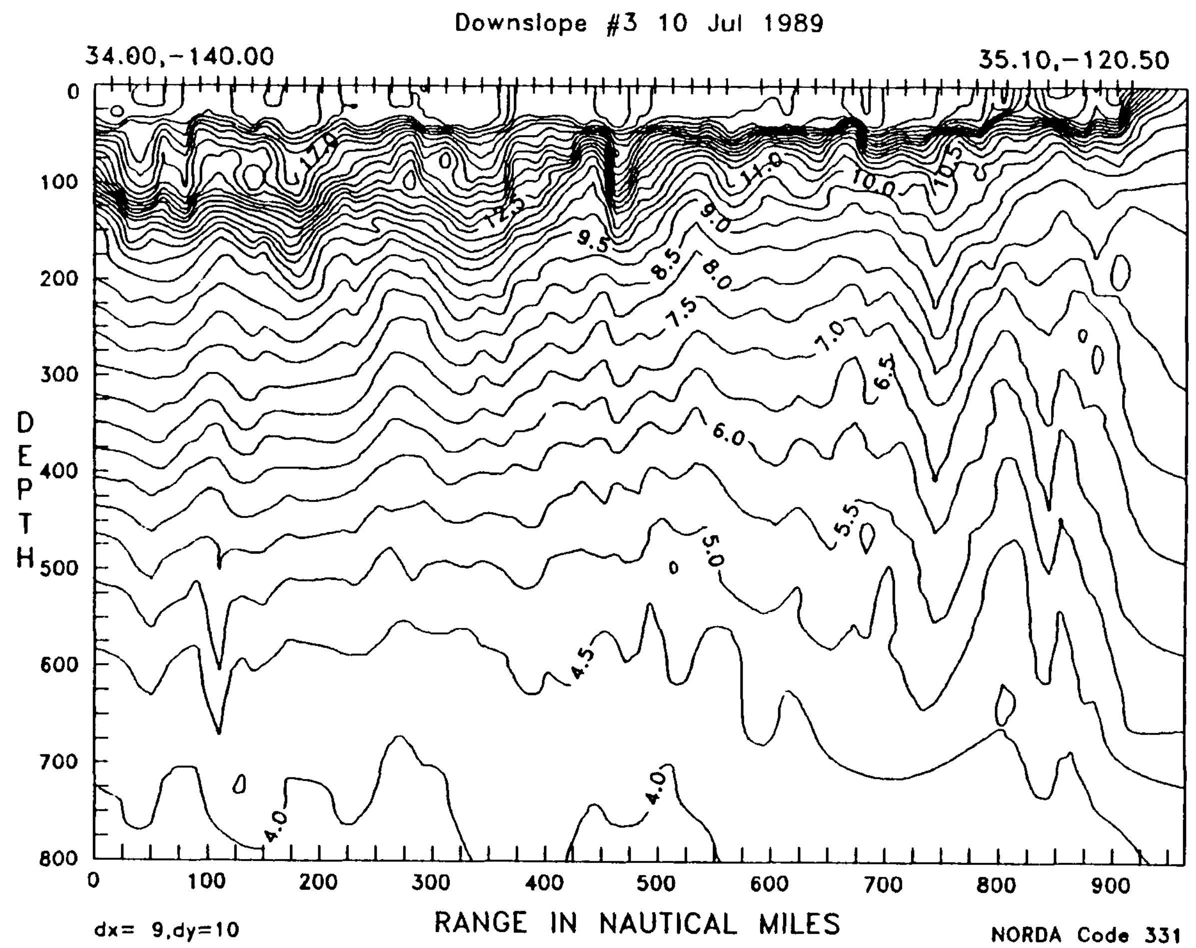

Downslope 8 July 1989
34.00,-140.00
35.00,-120.50
DEPTH
0
100
200
300
400
500
600
700
800
RANGE IN NAUTICAL MILES
900
17.0
14.5
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
NORDA Code 331

Figure 10 (b).



Downslope #3 10 Jul 1989
34.00,-140.00
35.10,-120.50
DEPTH
0
100
200
300
400
500
600
700
800
RANGE IN NAUTICAL MILES
900
12.0
12.5
11.0
10.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
dx= 9,dy=10
NORDA Code 331

Figure 10 (c).

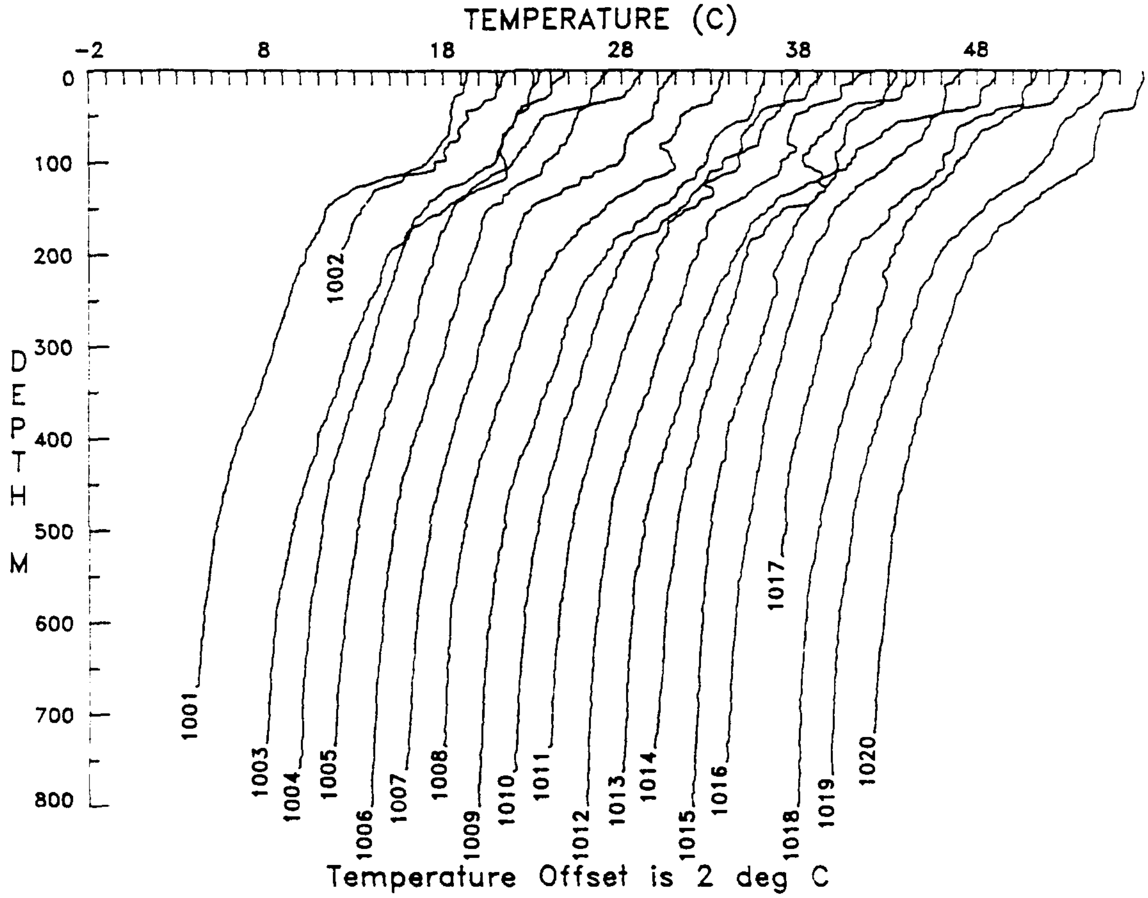
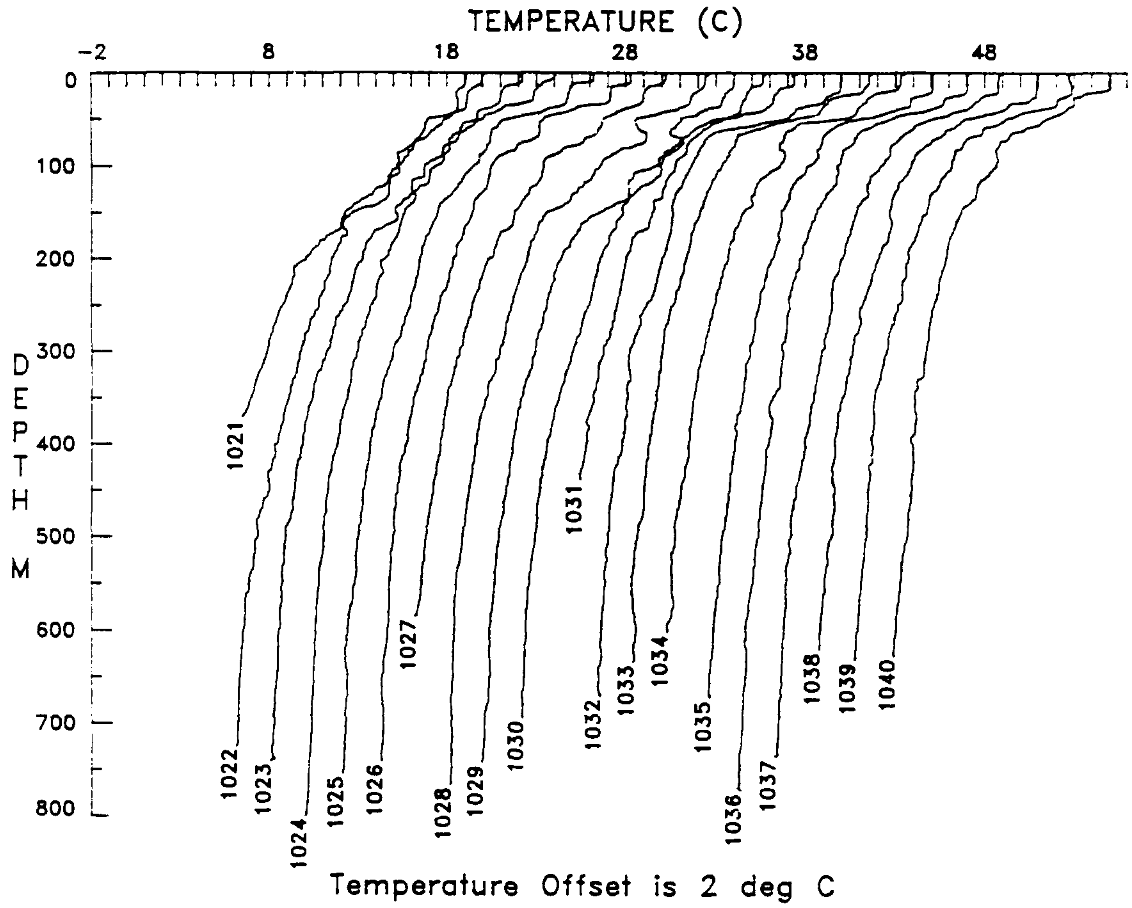

TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
Temperature Offset is 2 deg C

Figure 11 (a).



TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
Temperature Offset is 2 deg C

Figure 11 (b).

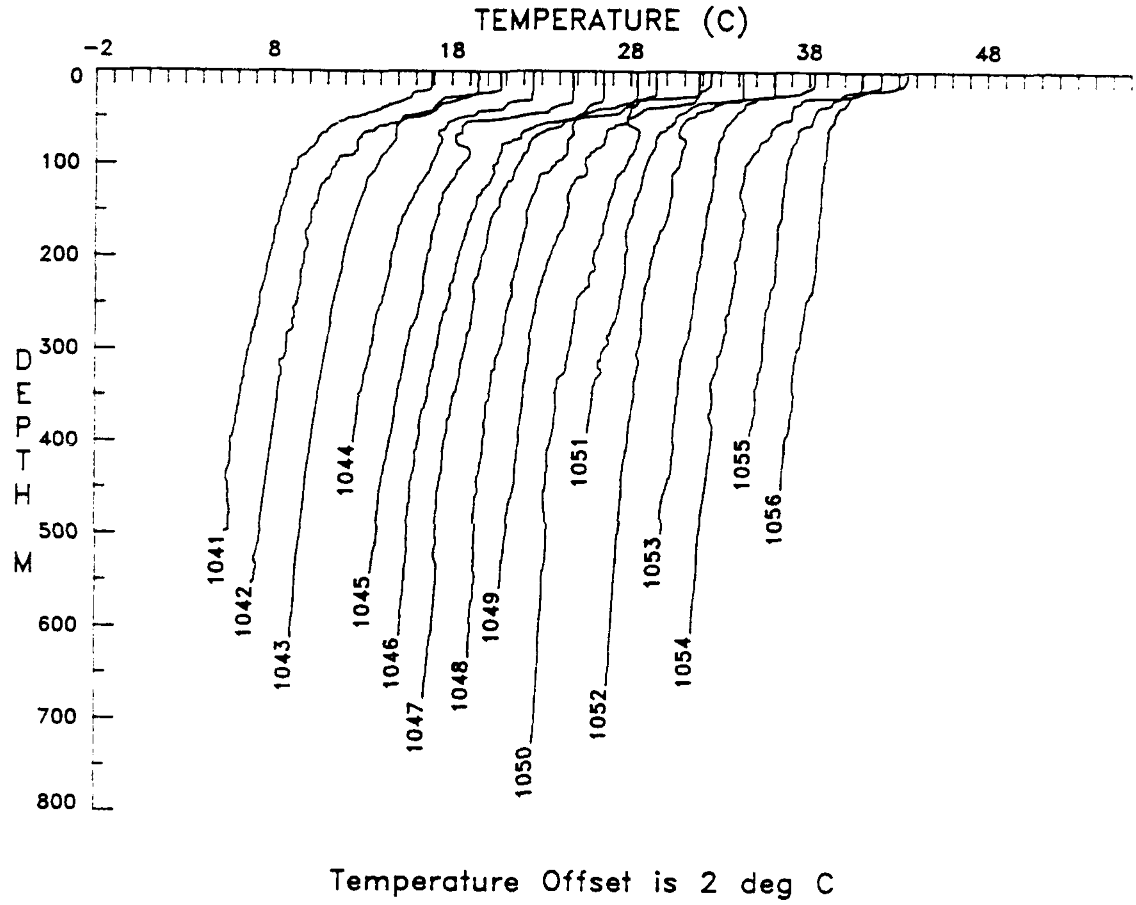
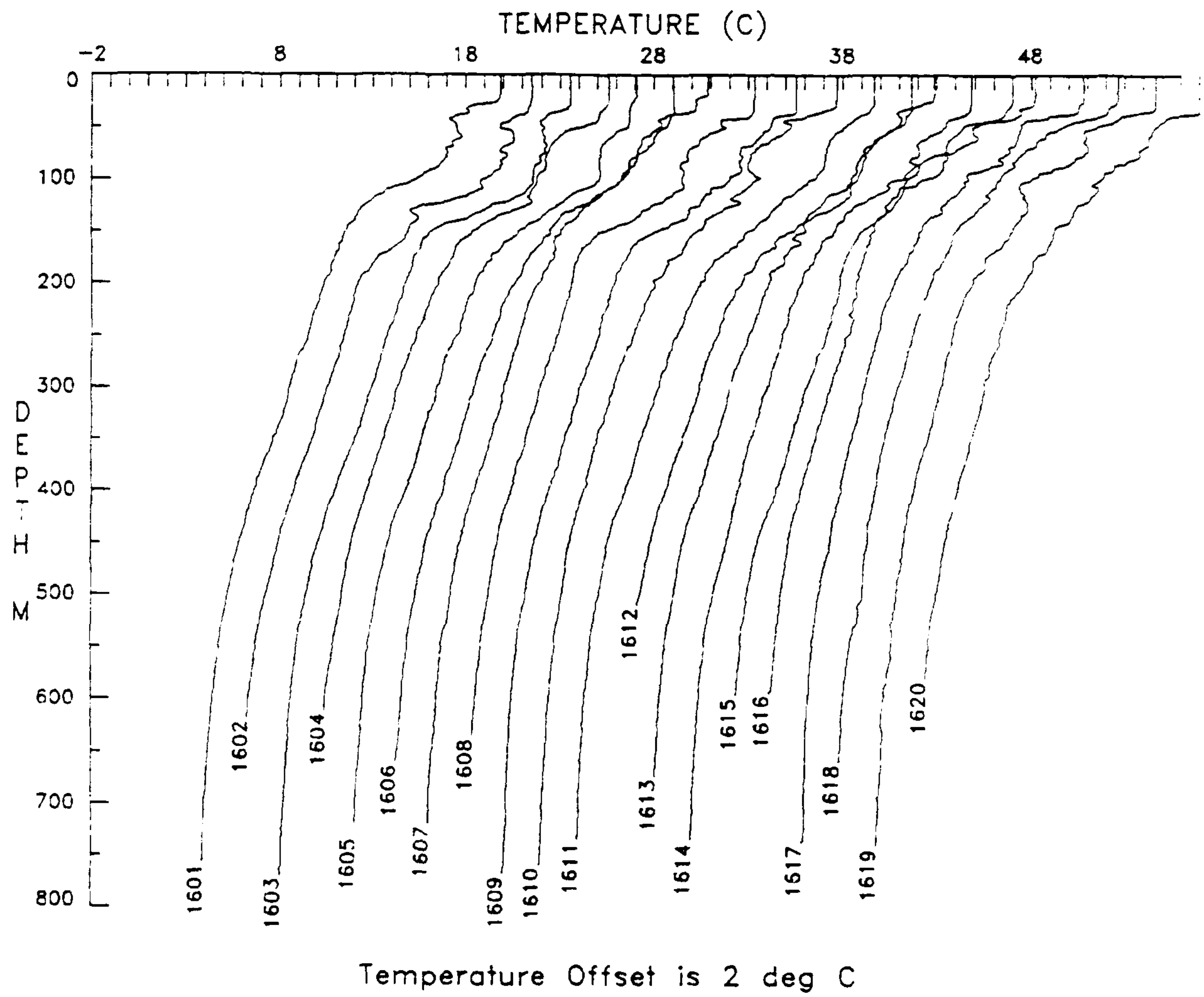
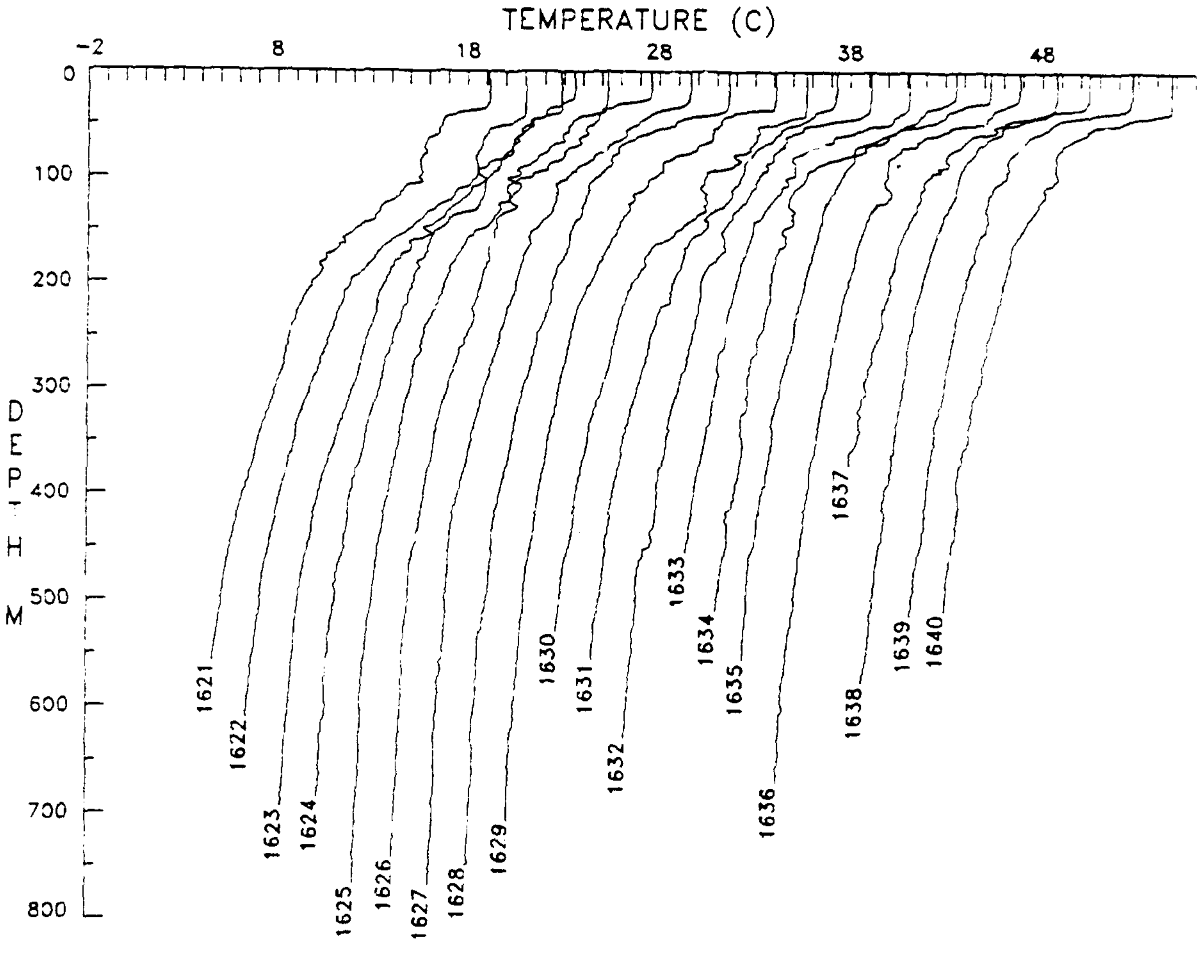

TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH
M
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
Temperature Offset is 2 deg C

Figure 11 (c).



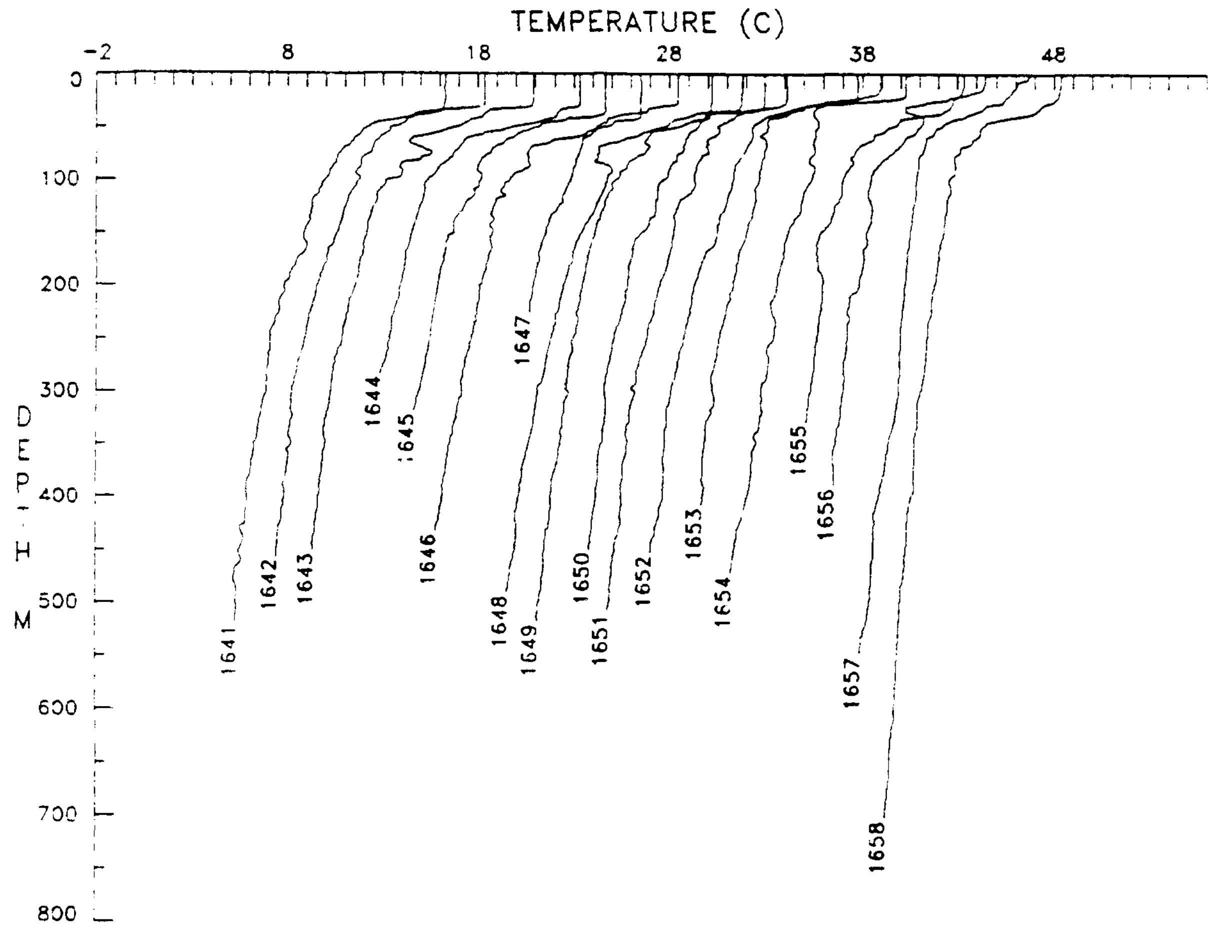
TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
Temperature Offset is 2 deg C

Figure 12 (a).



Temperature Offset is 2 deg C

Figure 12 (b).



Temperature Offset is 2 deg C

Figure 12 (c).

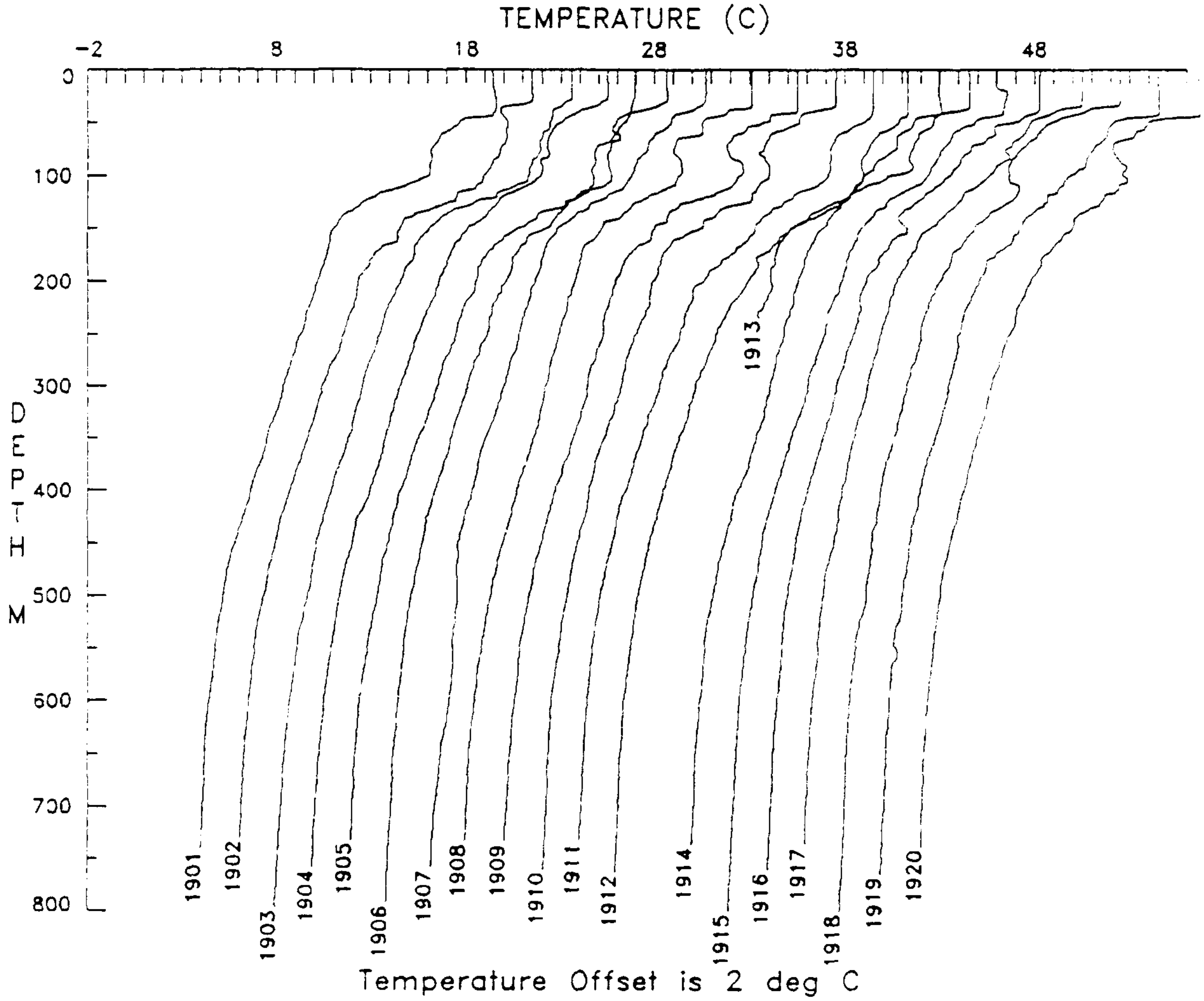

TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
Temperature Offset is 2 deg C

Figure 13 (a).

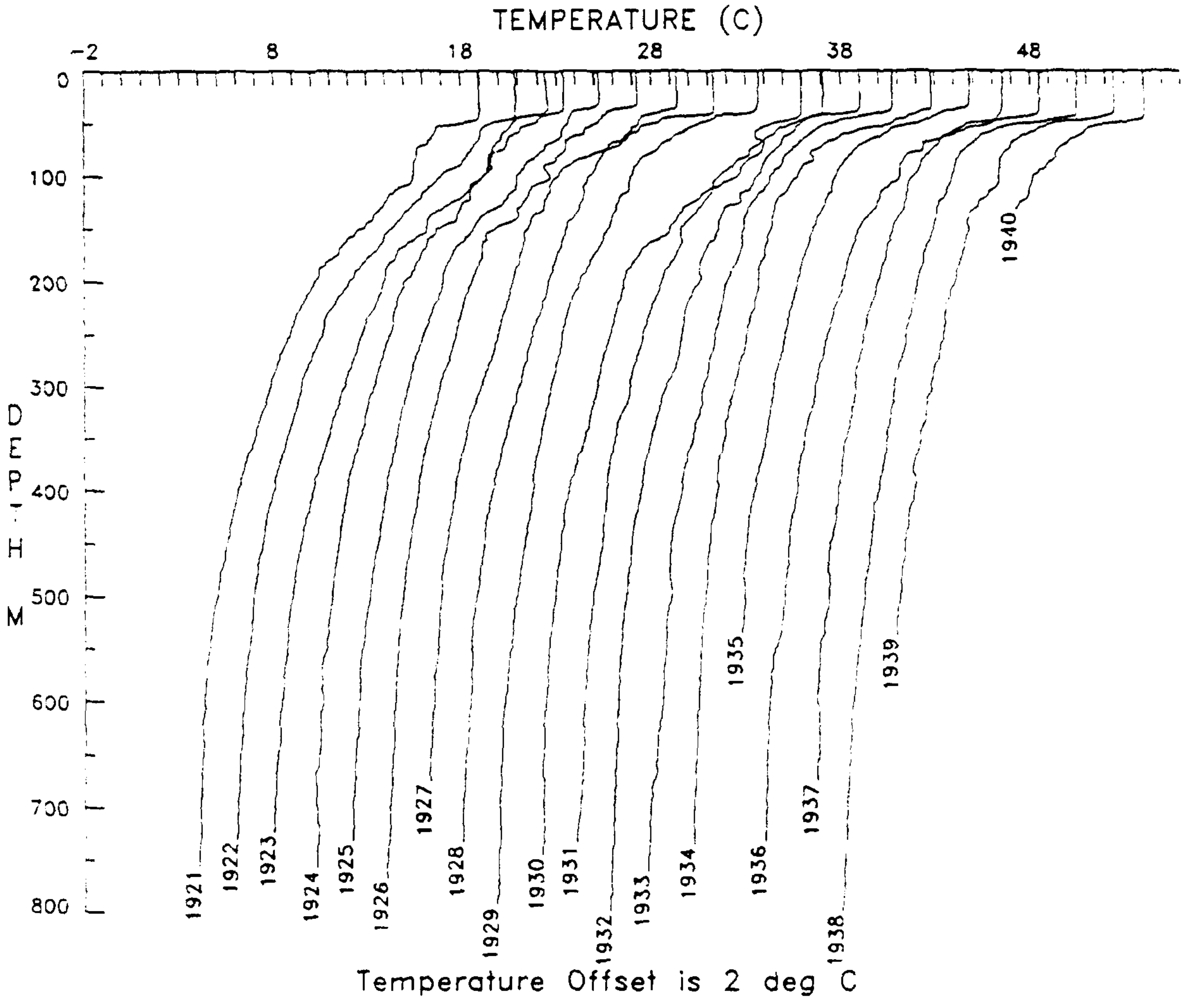
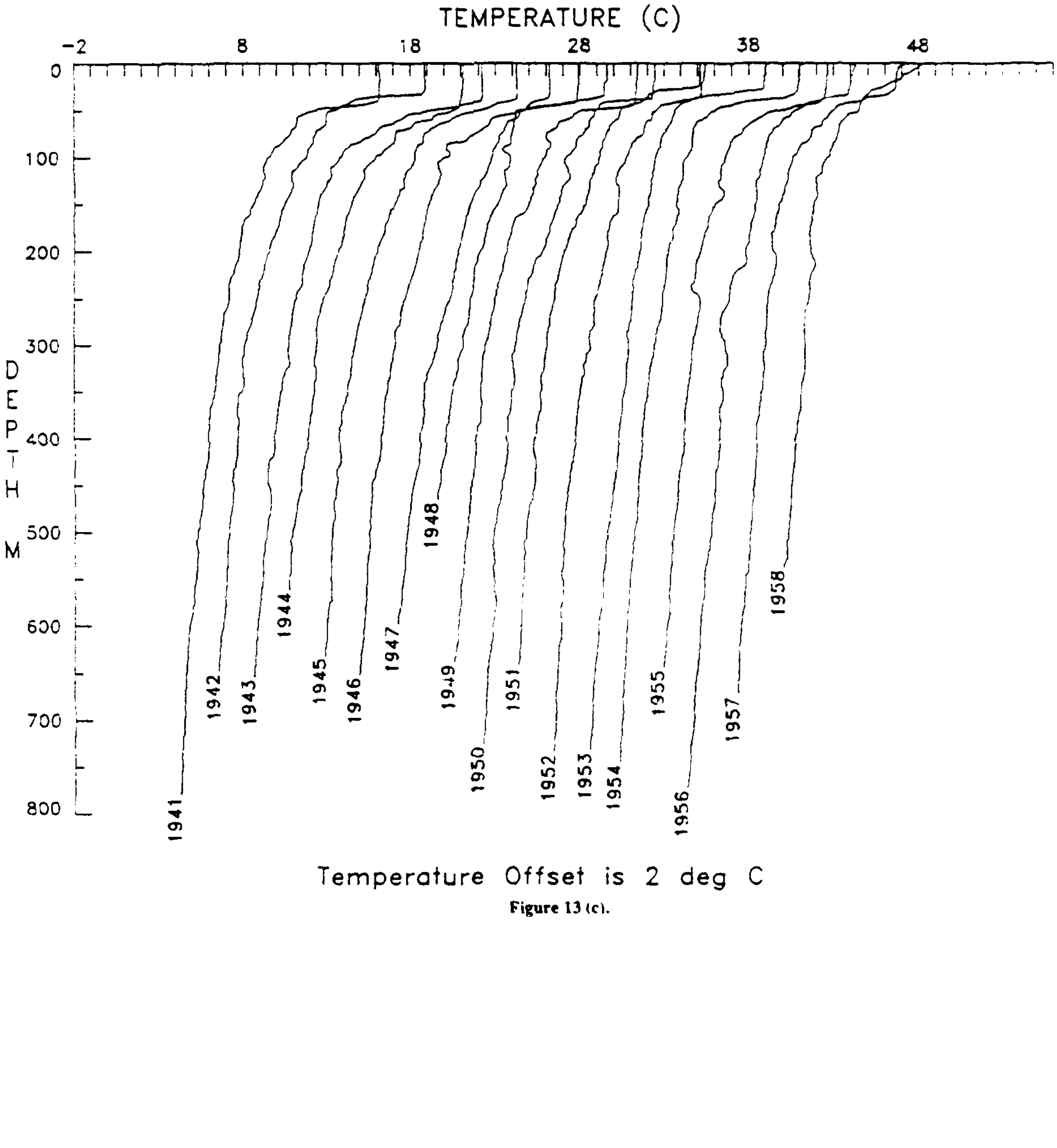

TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
Temperature Offset is 2 deg C

Figure 13 (b).



TEMPERATURE (C)
-2
8
18
28
38
48
0
100
200
300
400
500
600
700
800
DEPTH M
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
Temperature Offset is 2 deg C

Figure 13 (c).

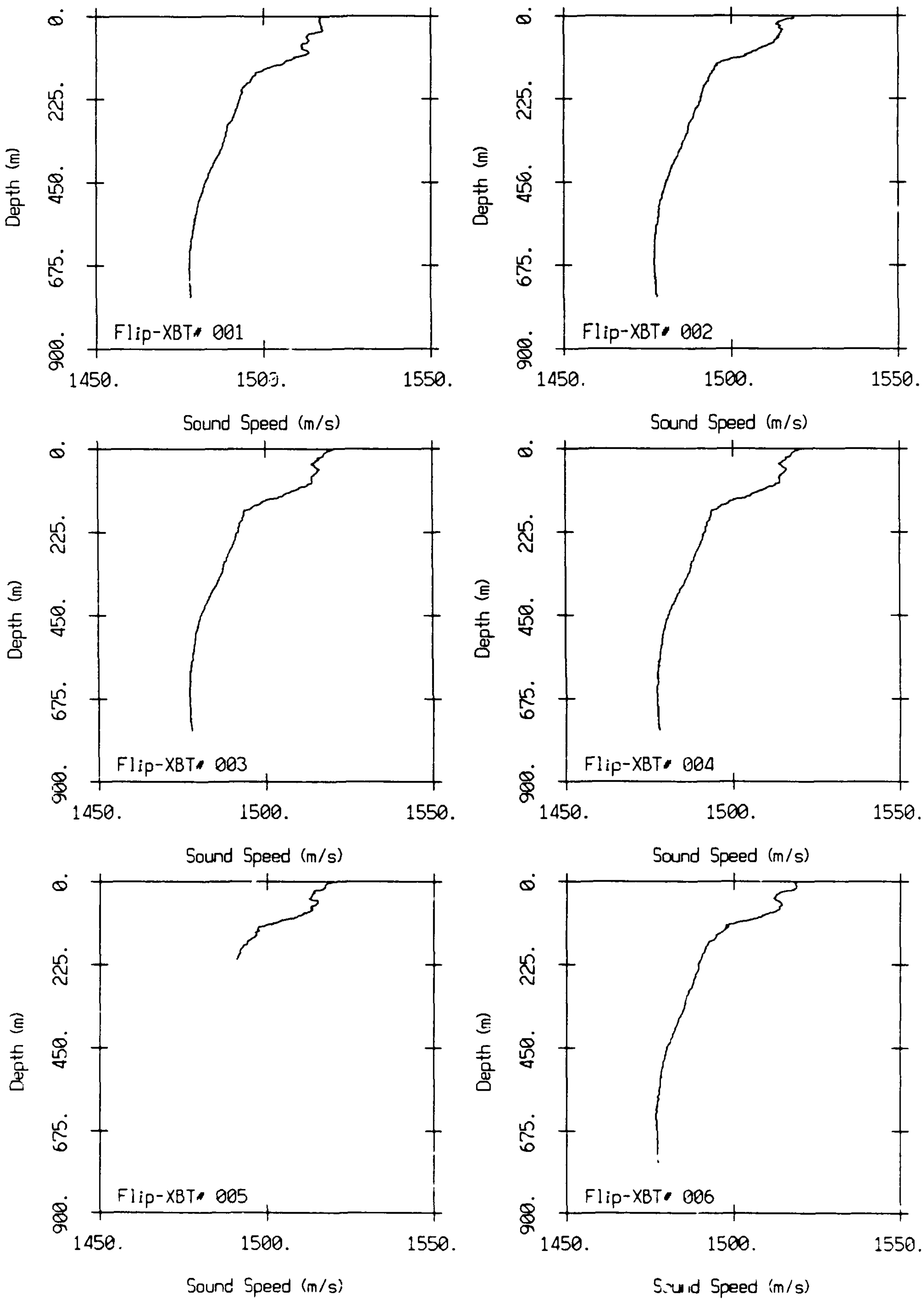
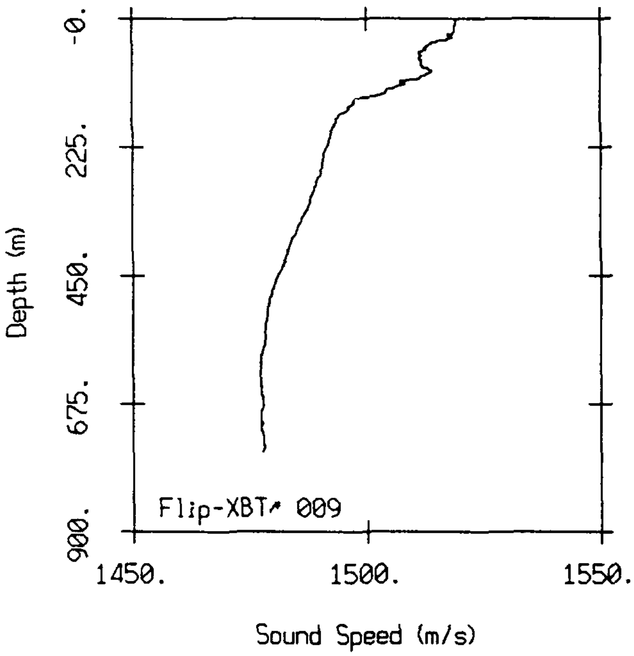
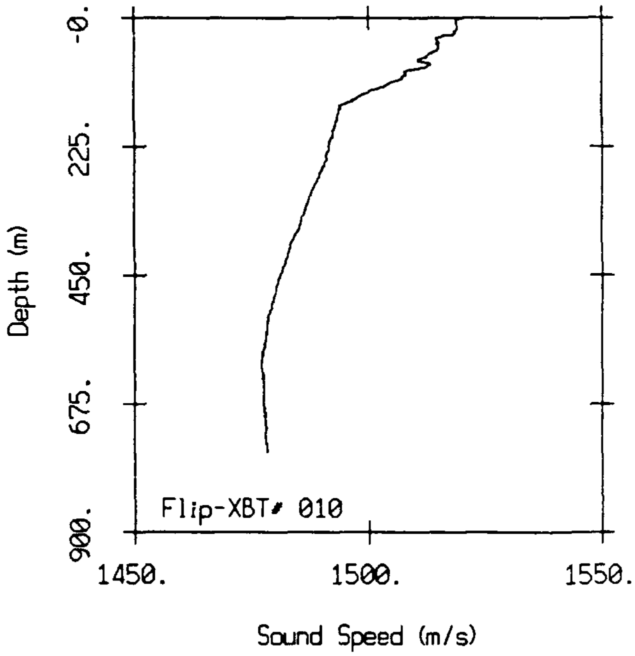

Depth (m)
0.
225.
450.
675.
900.
1450.
1500.
1550.
Sound Speed (m/s)
Flip-XBT# 001
Flip-XBT# 002
Flip-XBT# 003
Flip-XBT# 004
Flip-XBT# 005
Flip-XBT# 006

Figure 14.





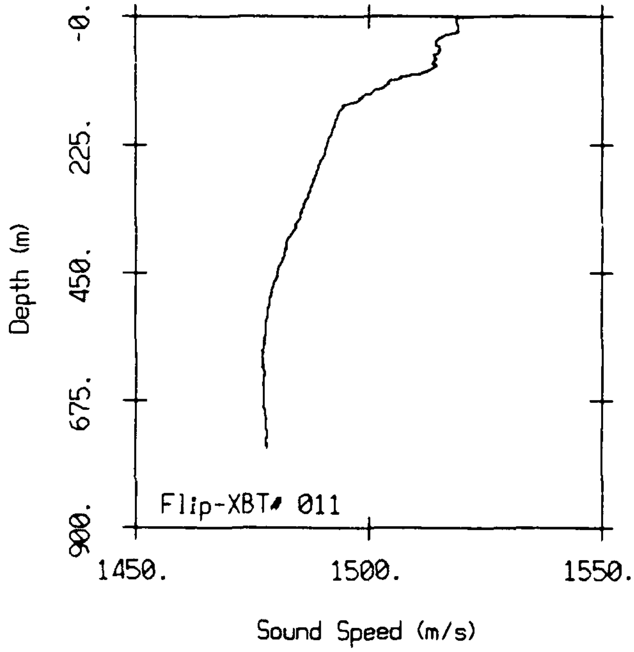


Figure 14 (cont.)

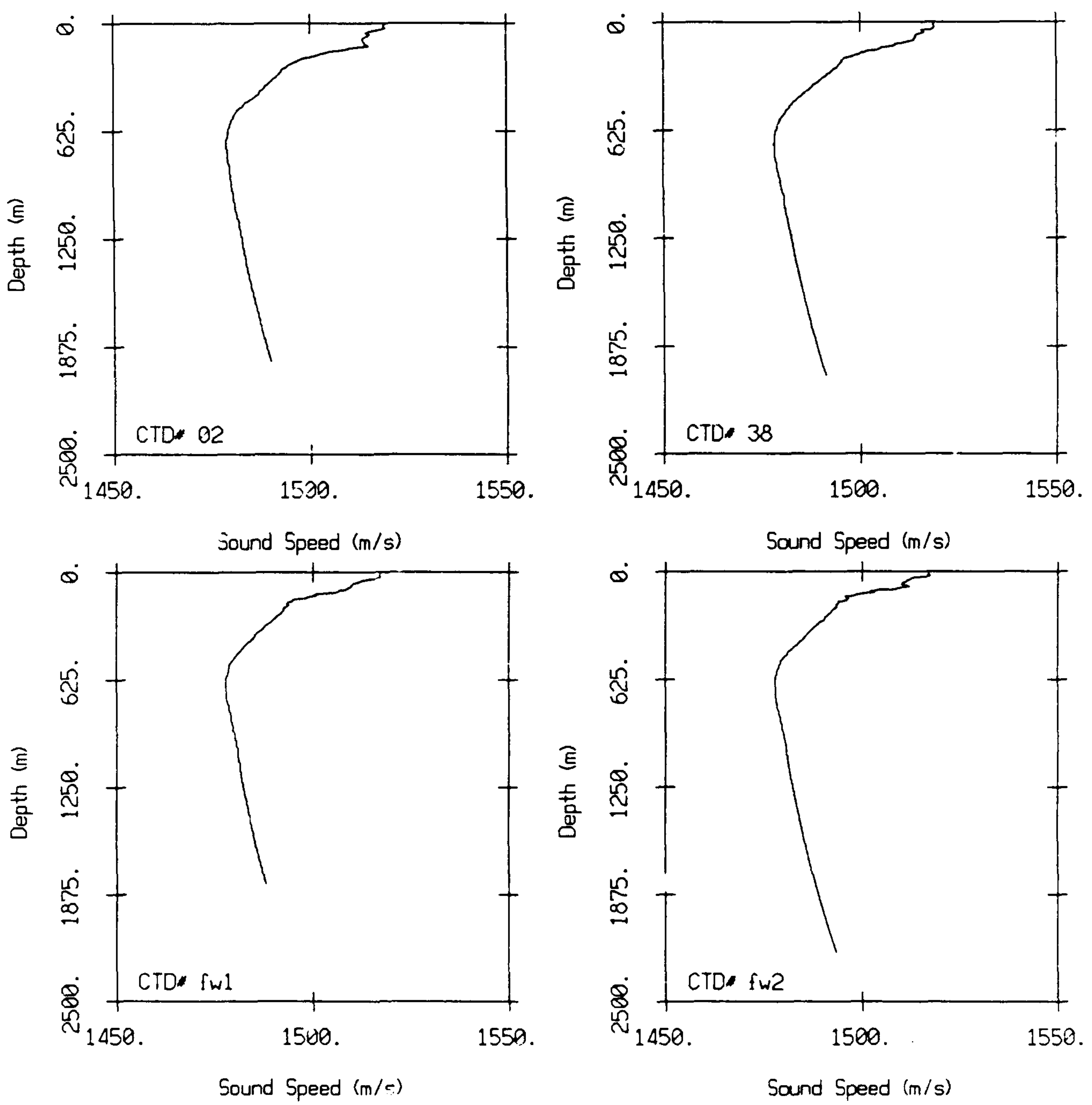
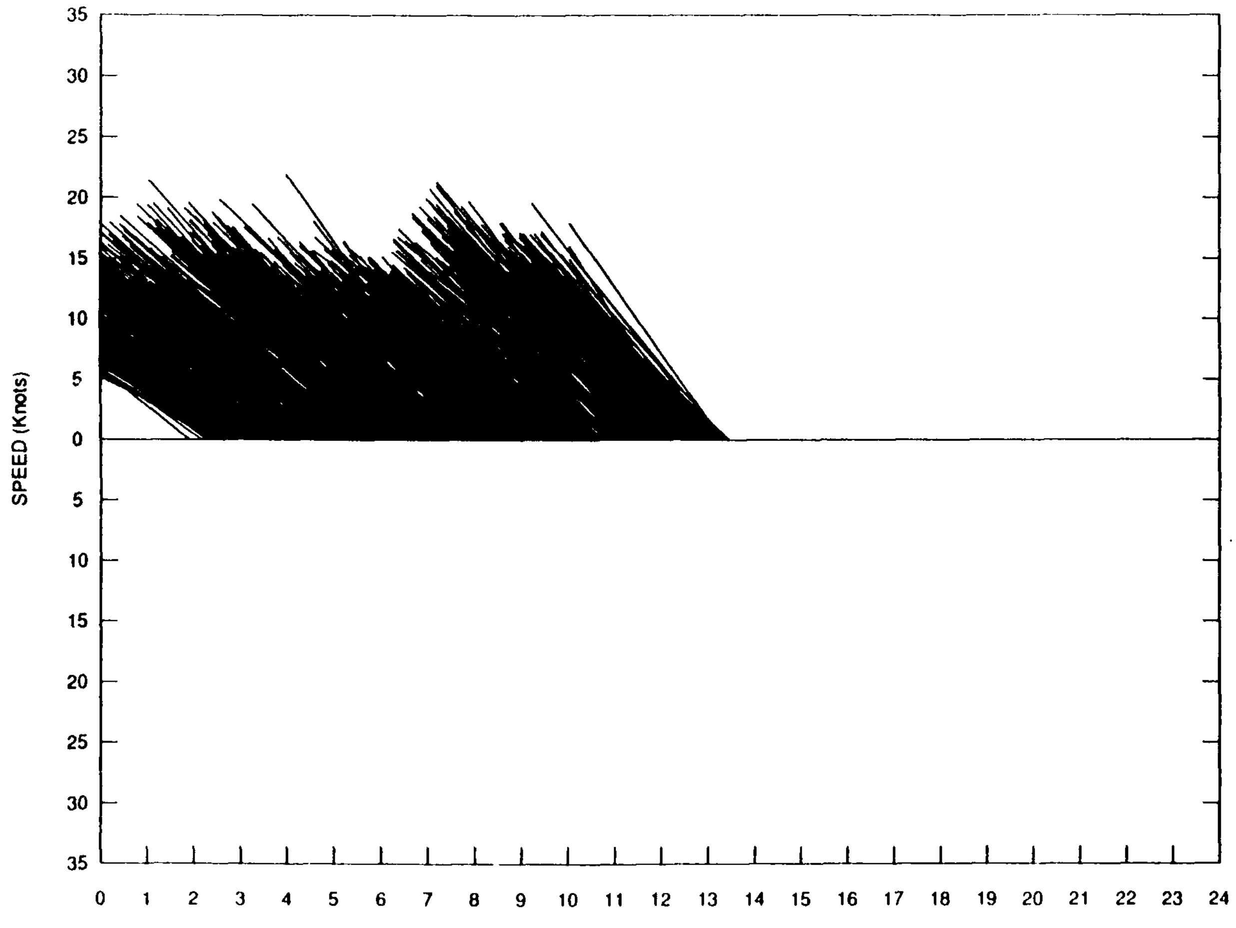

Depth (m)
0.
625.
1250.
1875.
2500.
CTD# 02
1450.
1500.
1550.
Sound Speed (m/s)
CTD# 38
CTD# fw1
CTD# fw2

Figure 15.

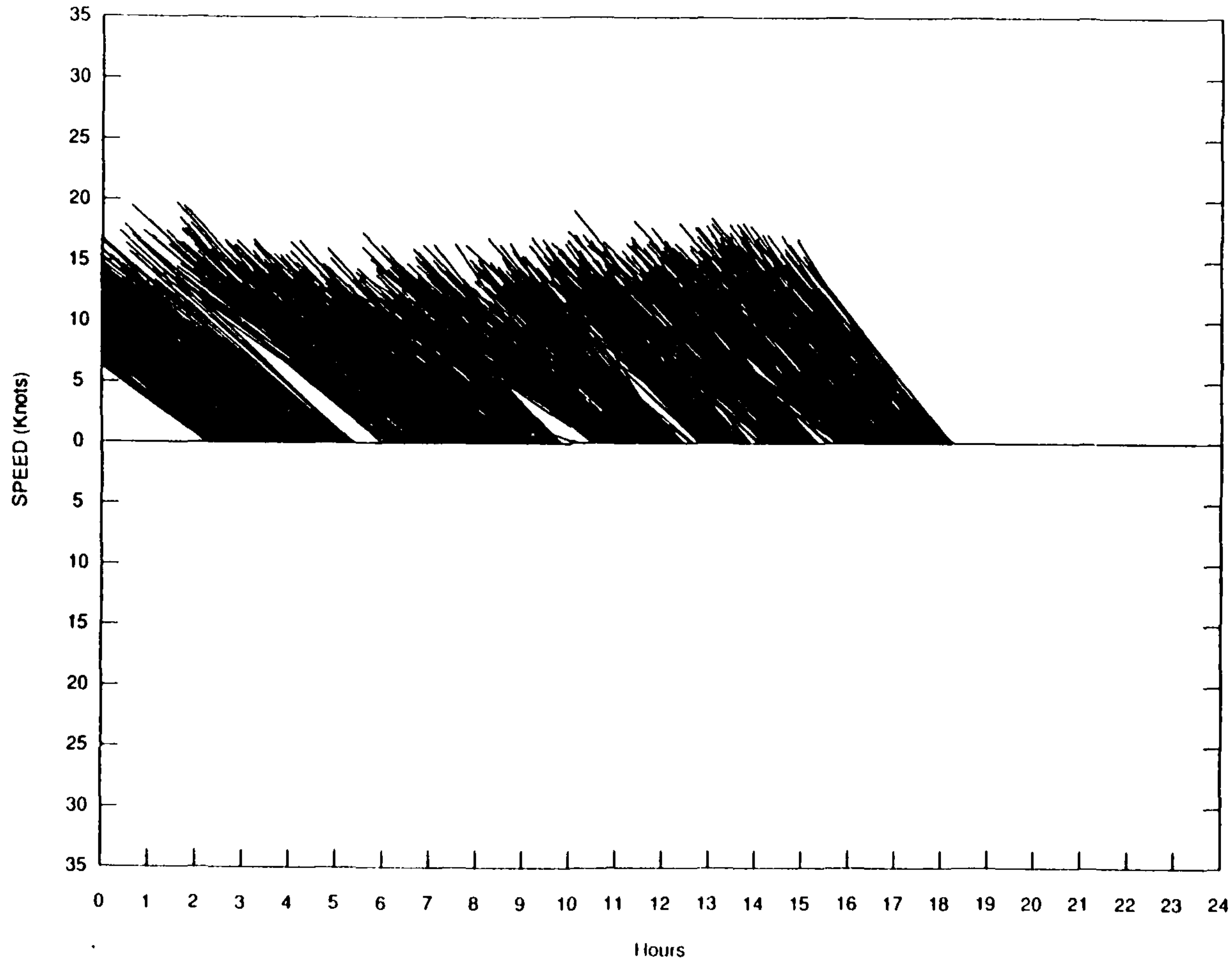
Wind direction from R/V New Horizon track data



Wind direction for Julian Day 185

Figure 16.

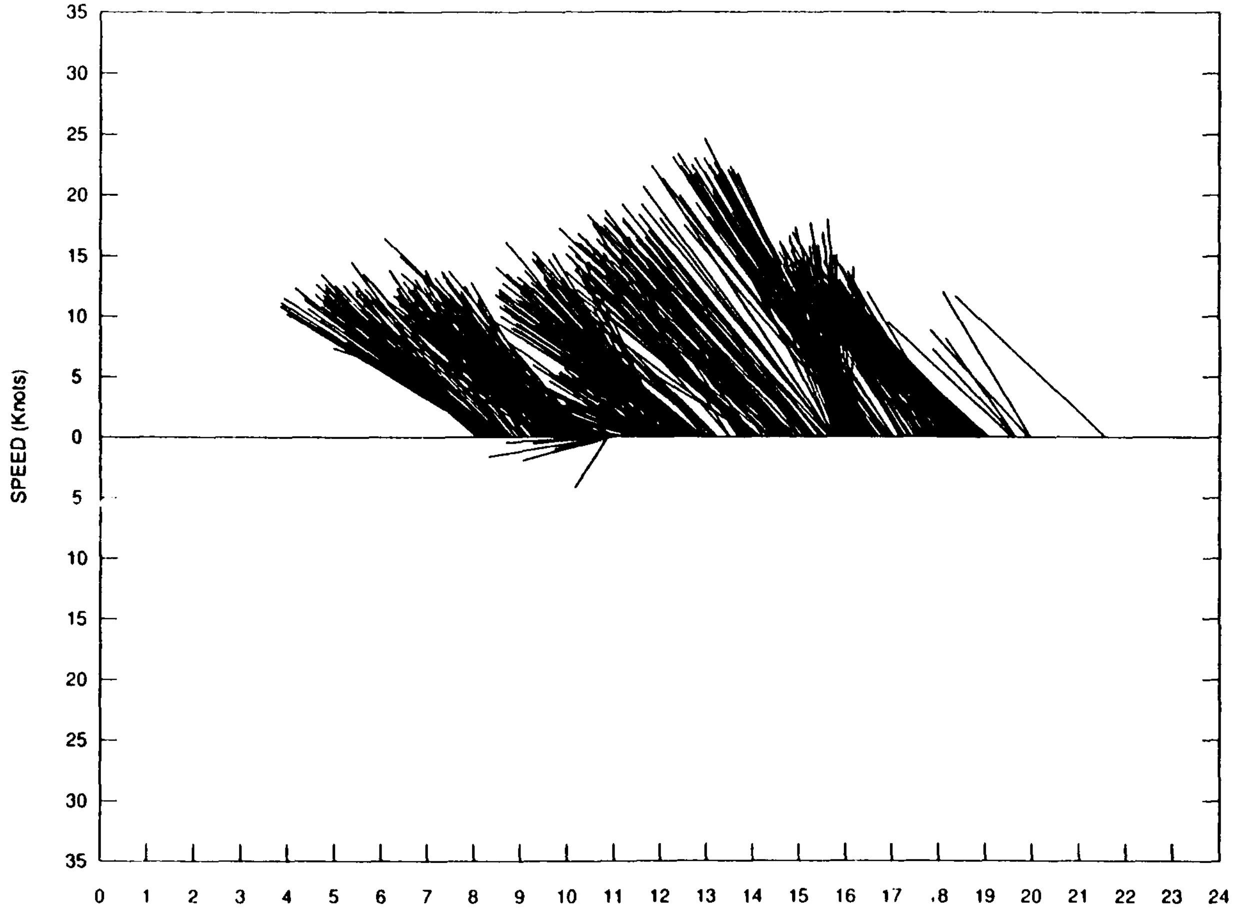
Wind direction from R/V New Horizon track data



Wind direction for Julian Day 186

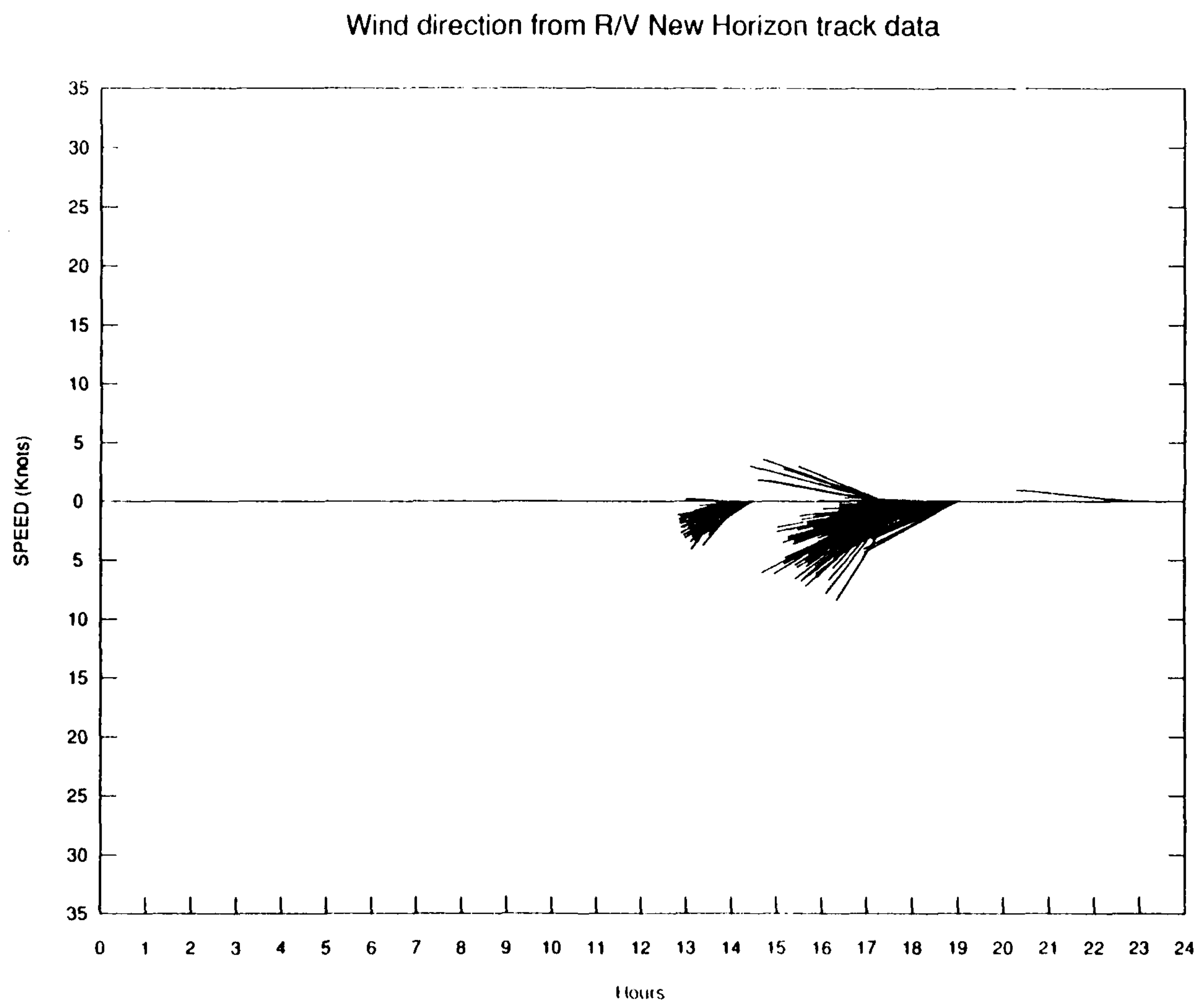
Figure 16 (cont.)

Wind direction from R/V New Horizon track data



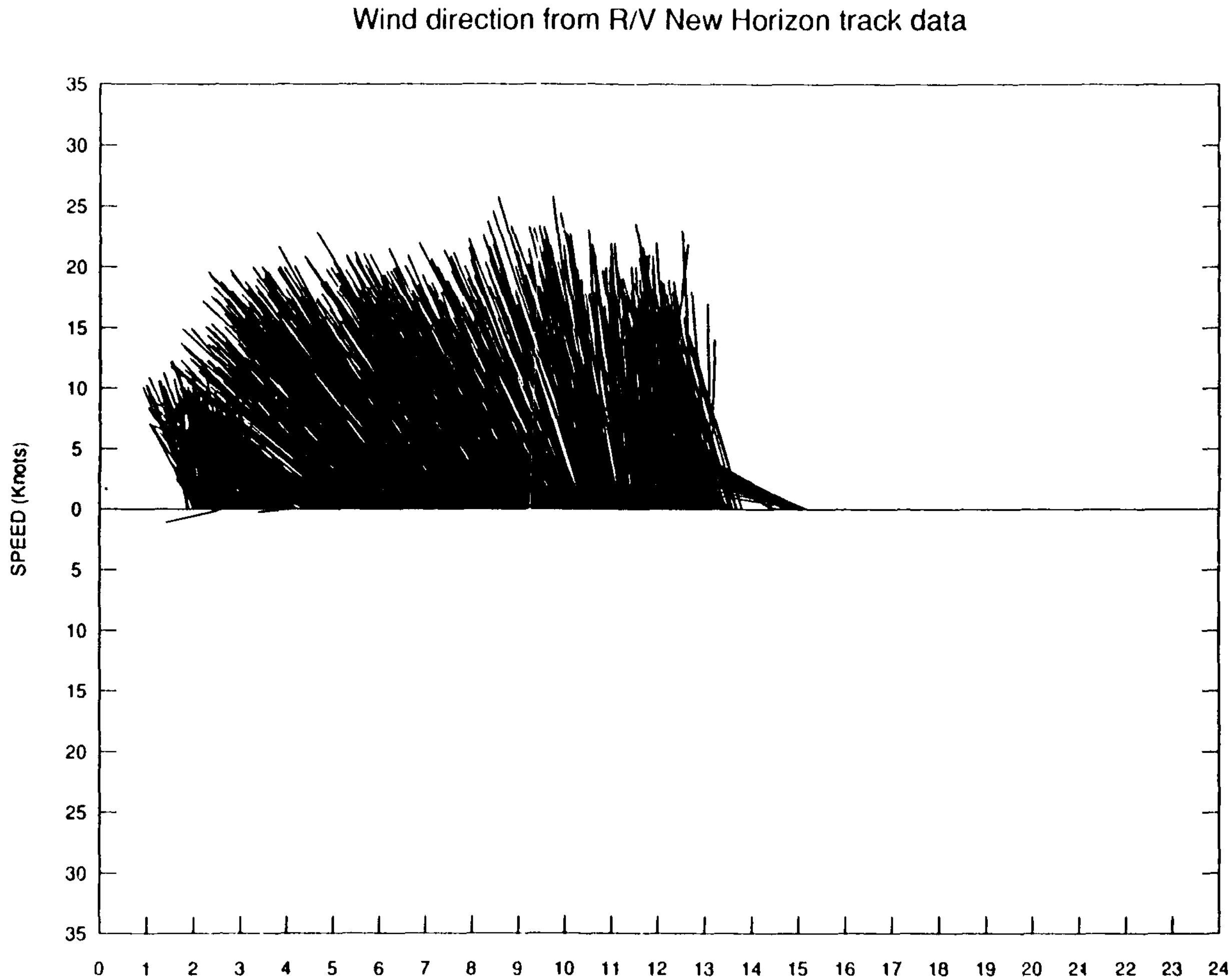
Wind direction for Julian Day 187

Figure 16 (cont.)



Wind direction for Julian Day 188

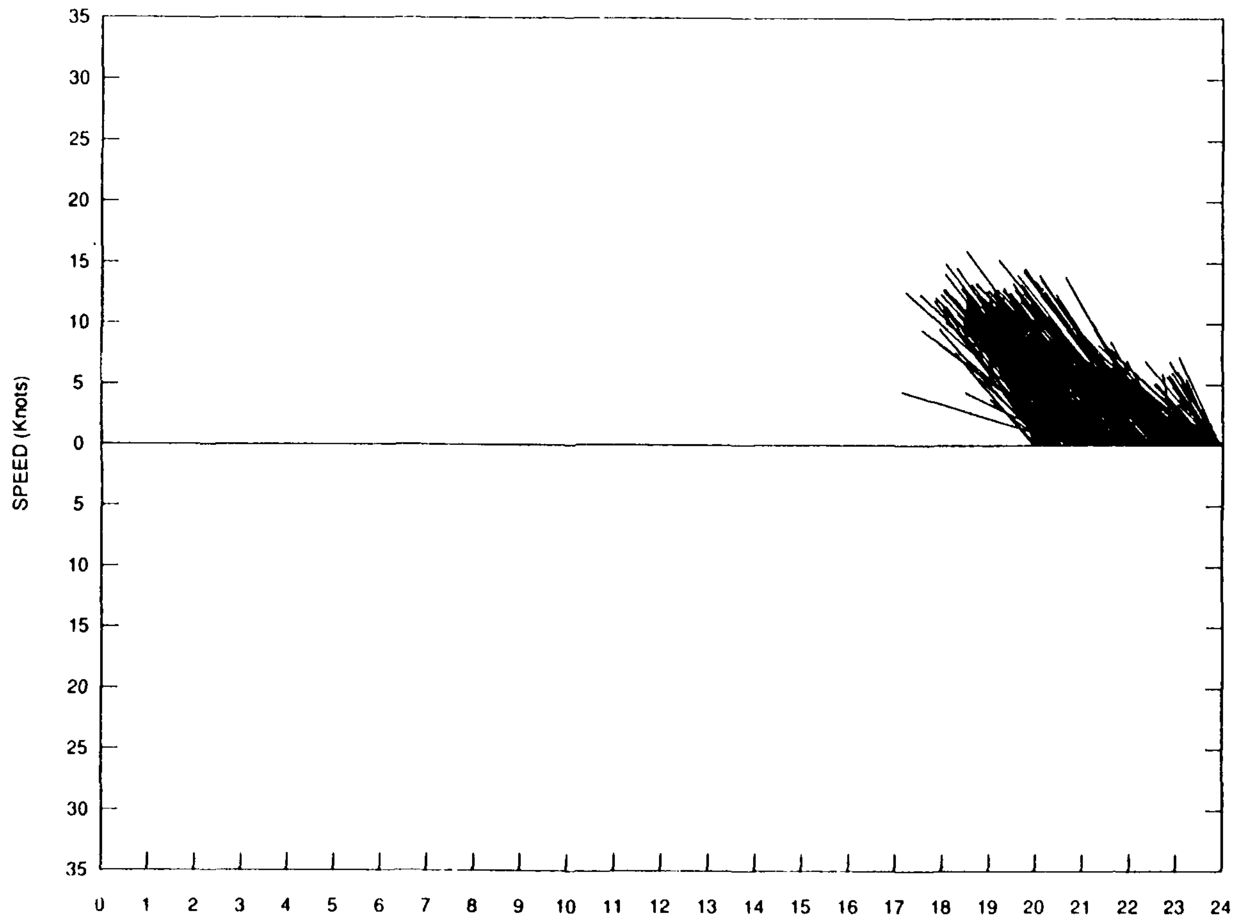
Figure 16 (cont.)



Hours
Wind direction for Julian Day 189

Figure 16 (cont.)

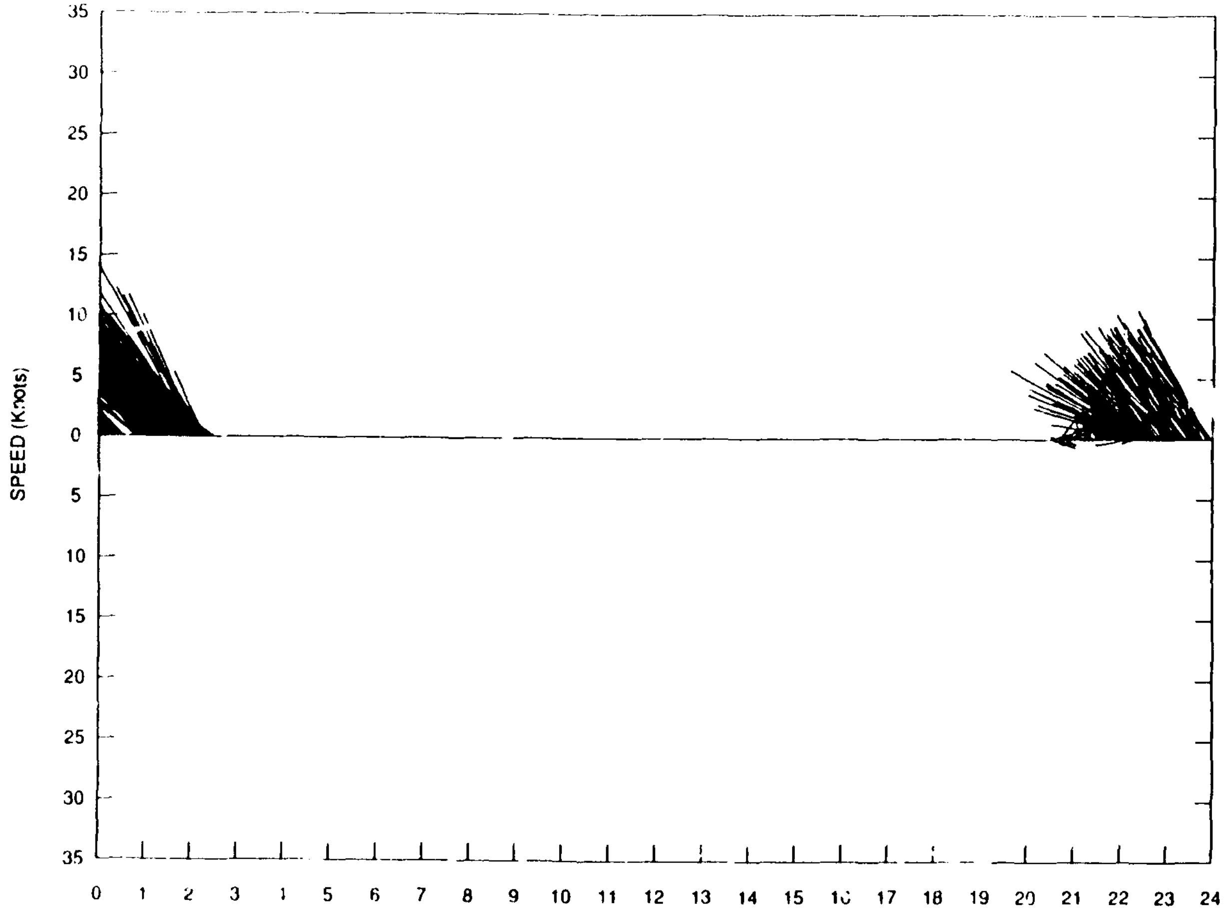
Wind direction from R/V New Horizon track data



Wind direction for Julian Day 191

Figure 16 (cont.)

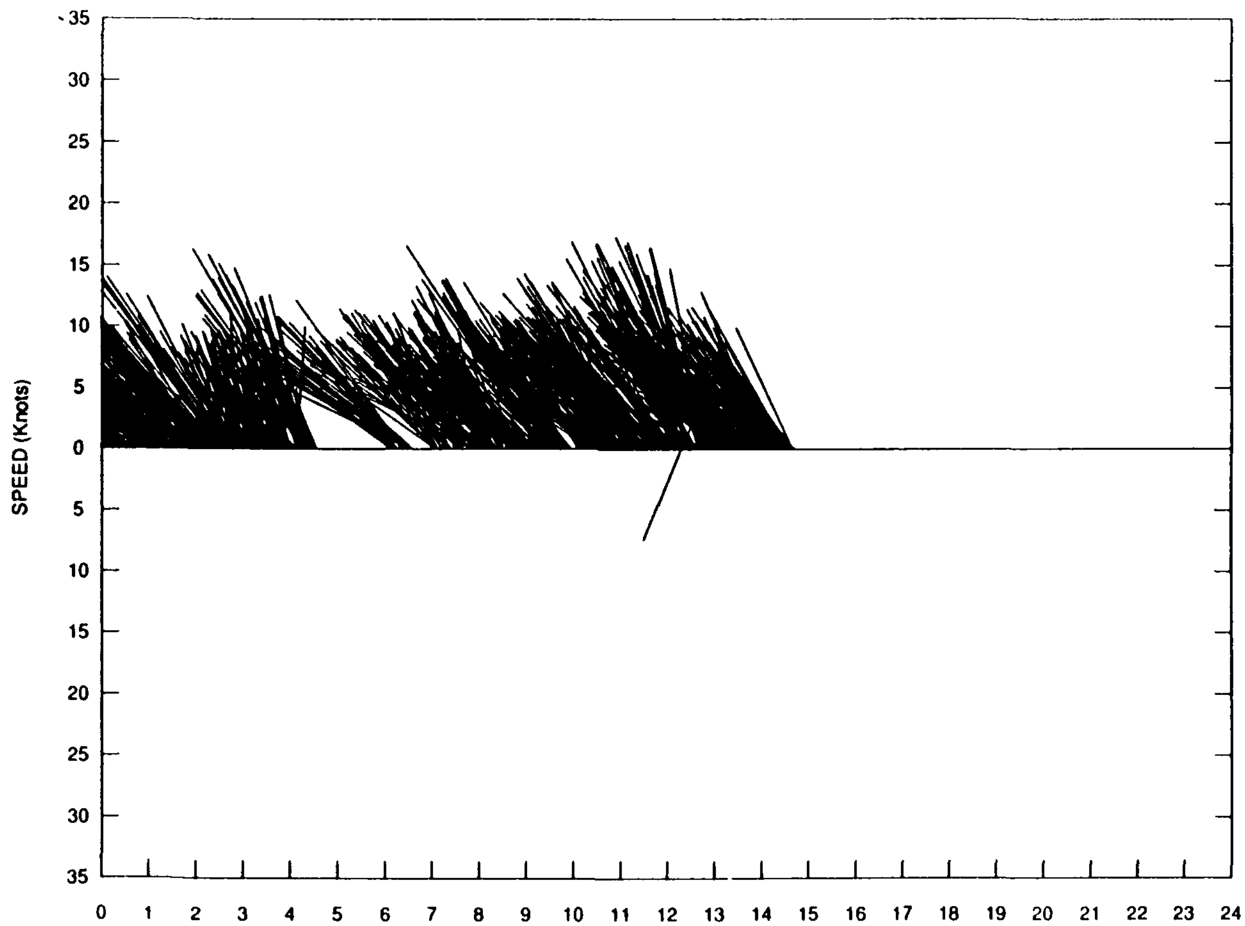
Wind direction from R/V New Horizon track data



Wind direction for Julian Day 192

Figure 16 (cont.)

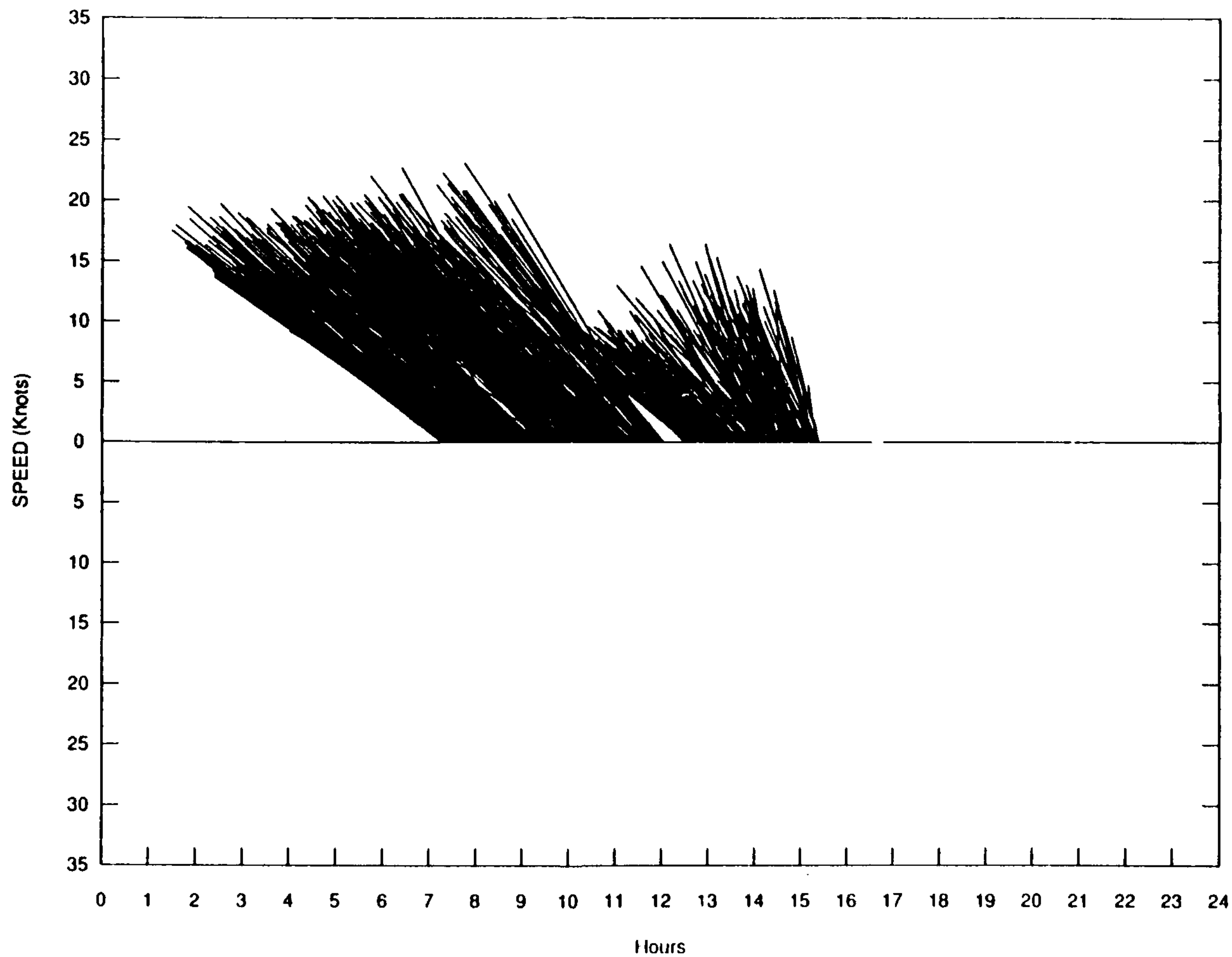
Wind direction from R/V New Horizon track data



Wind direction for Julian Day 193

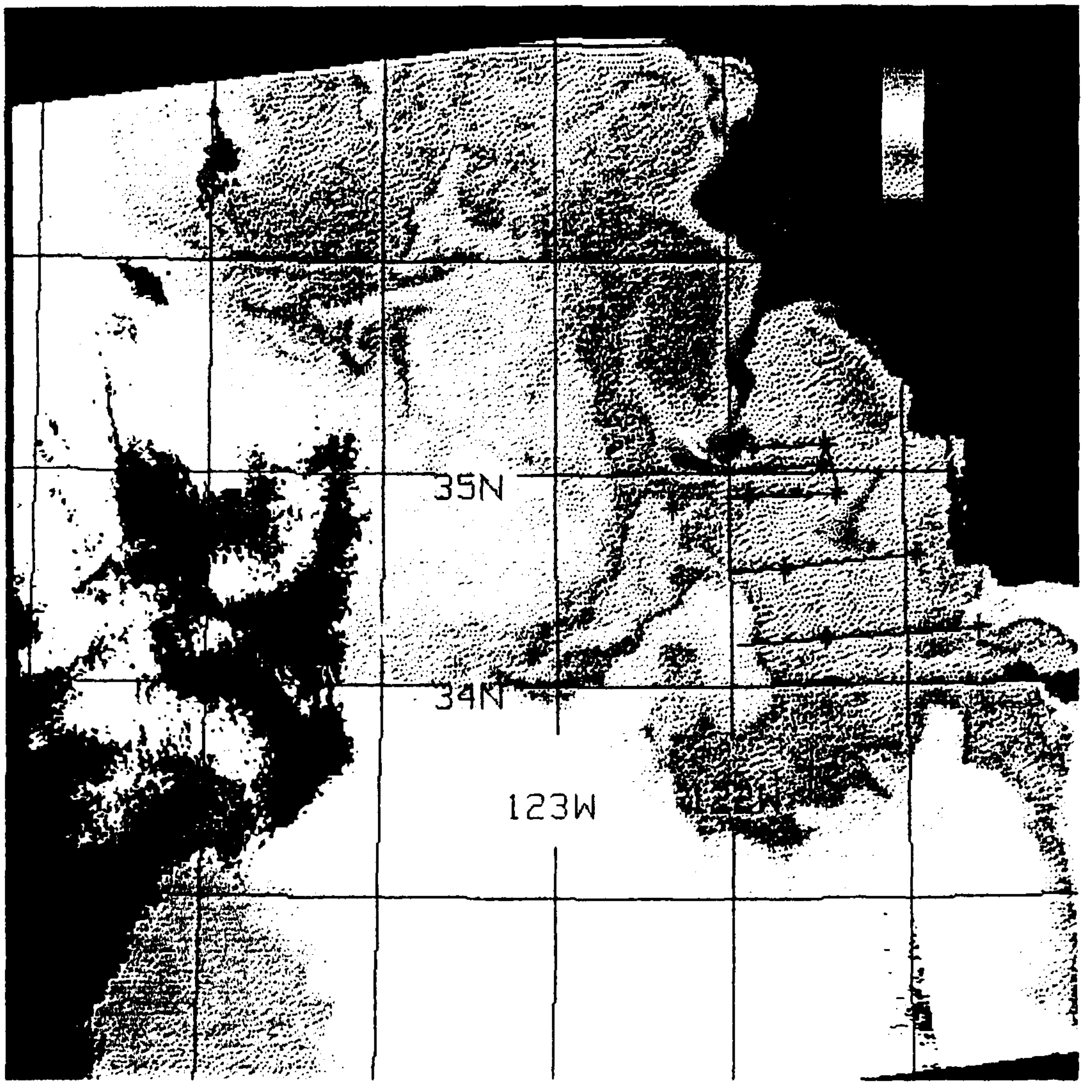
Figure 16 (cont.)

Wind direction from R/V New Horizon track data

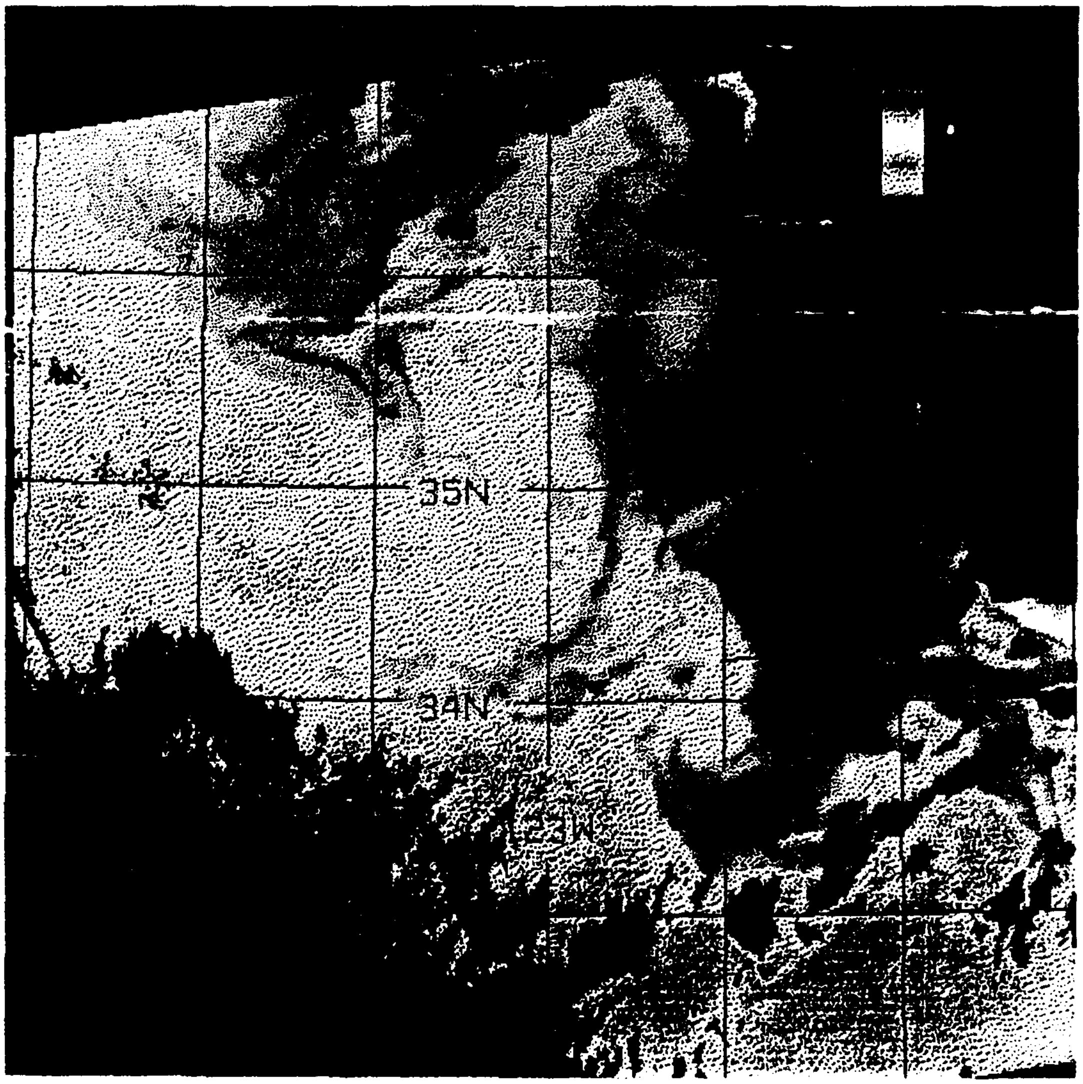


Wind direction for Julian Day 194

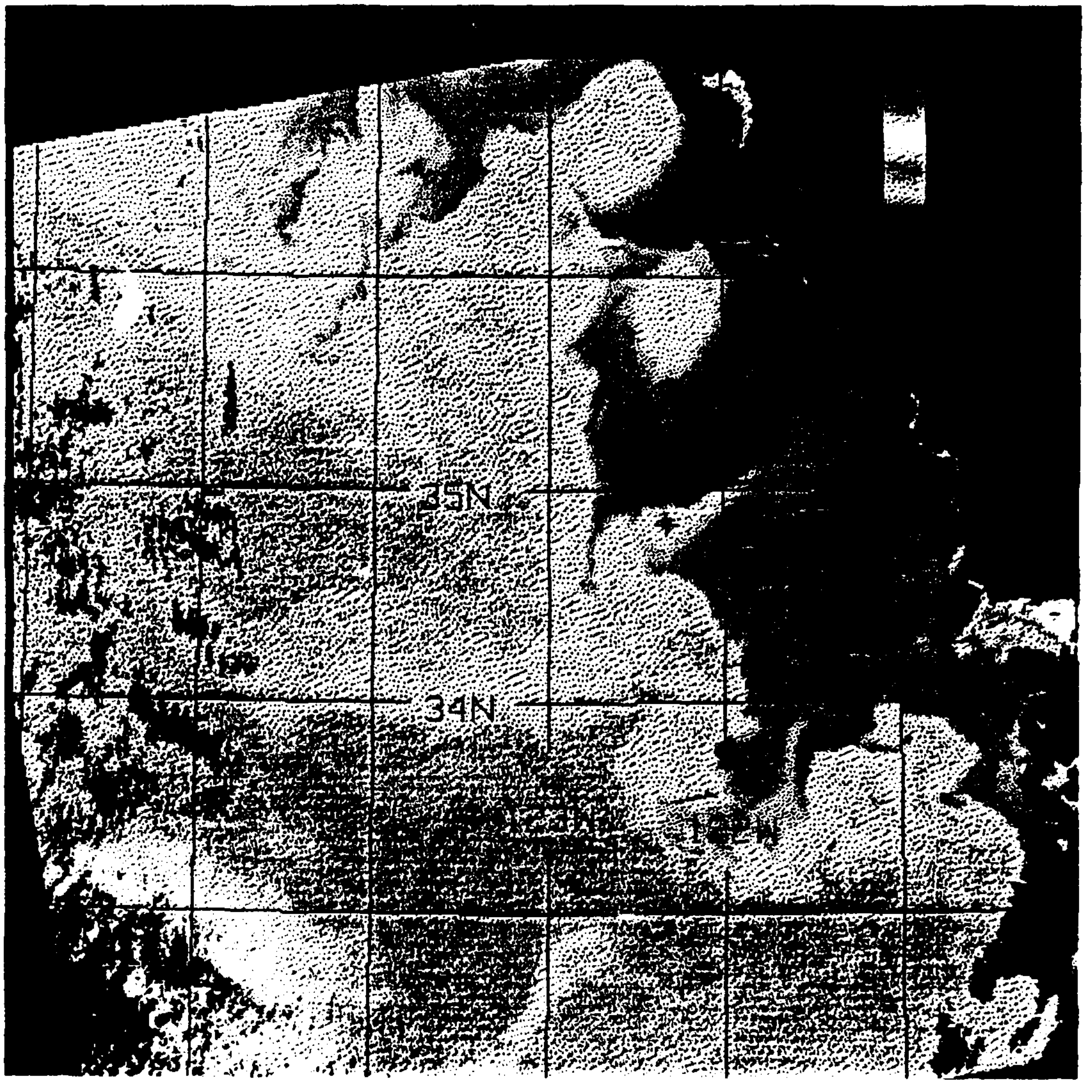
Figure 16 (cont.)



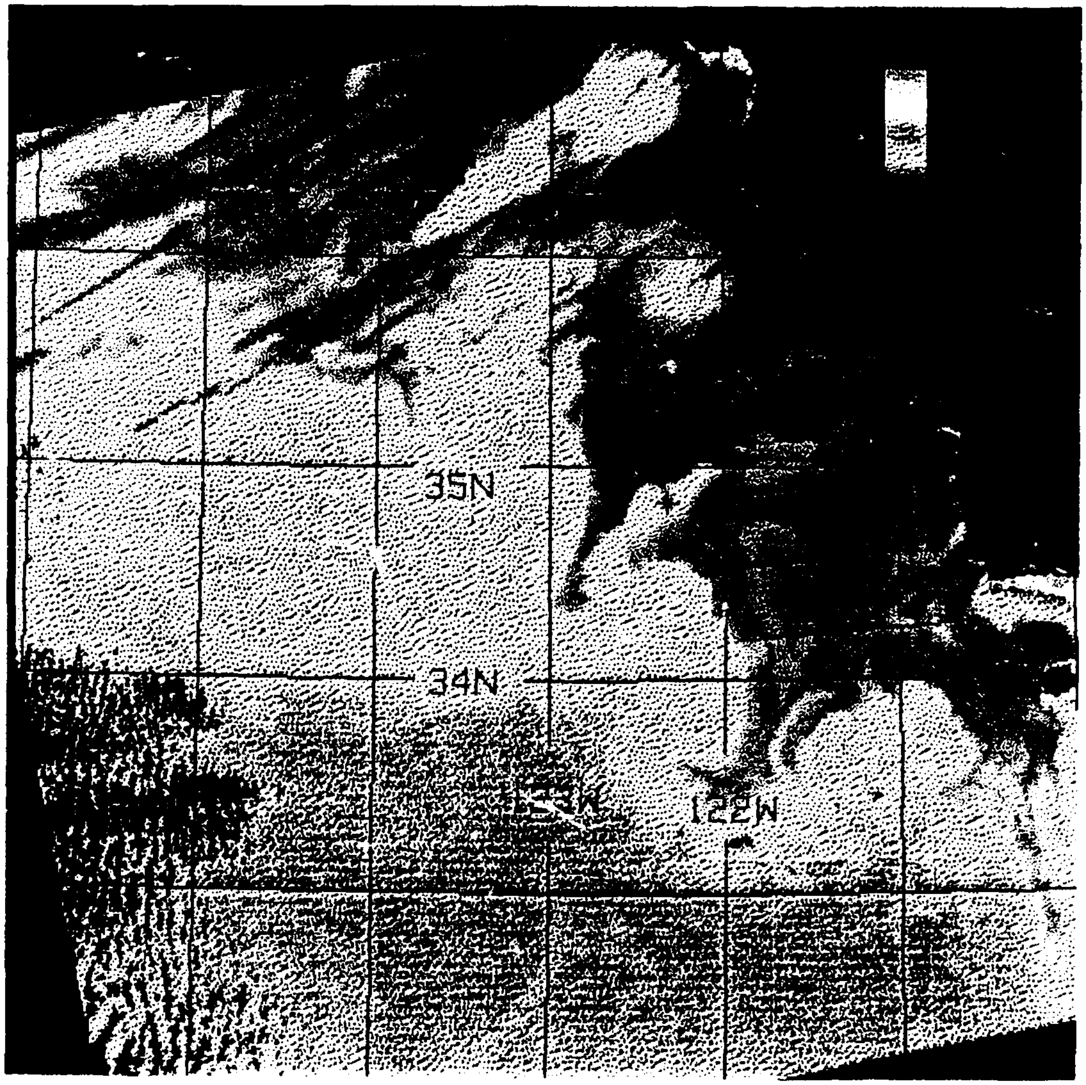
Picture #1



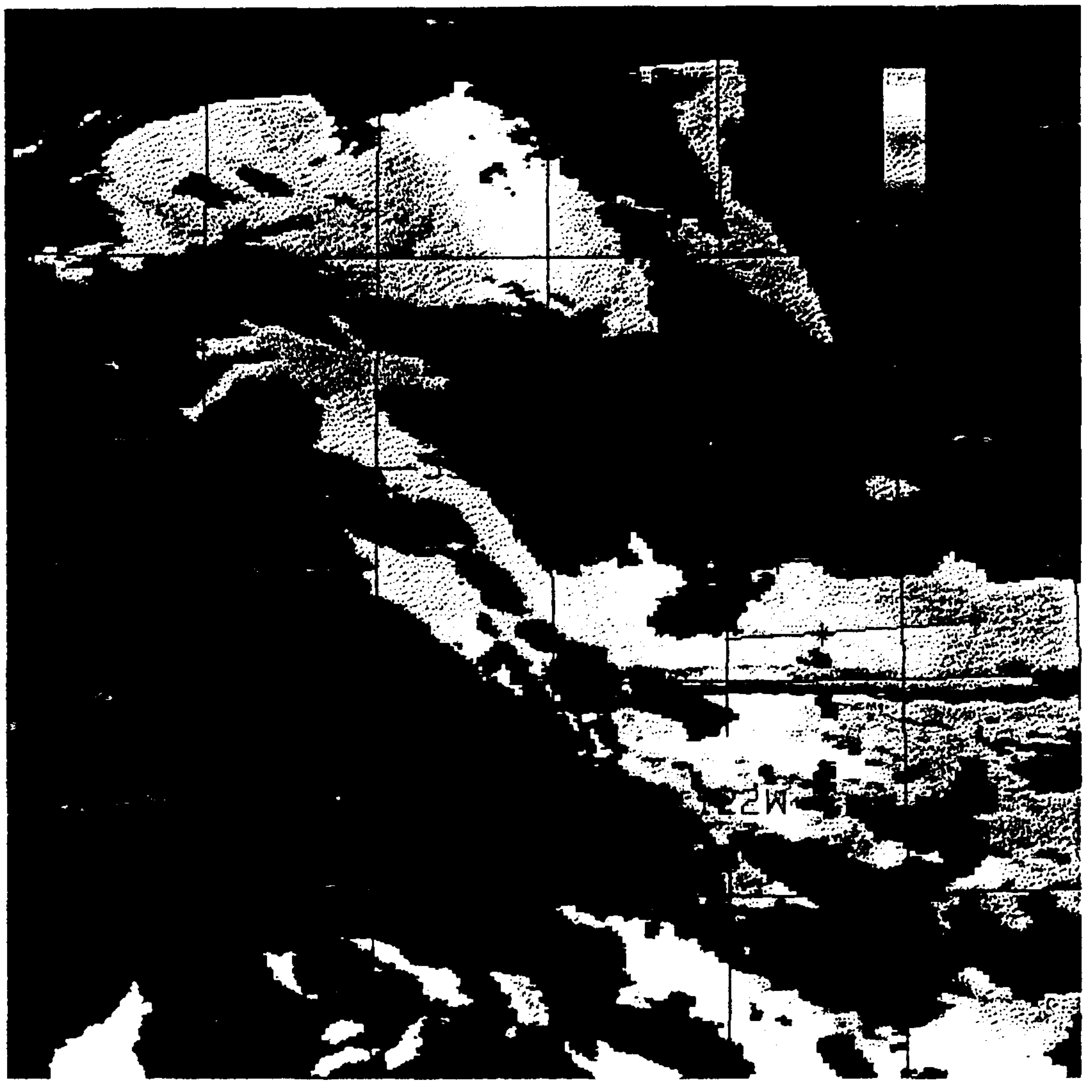
Picture #2



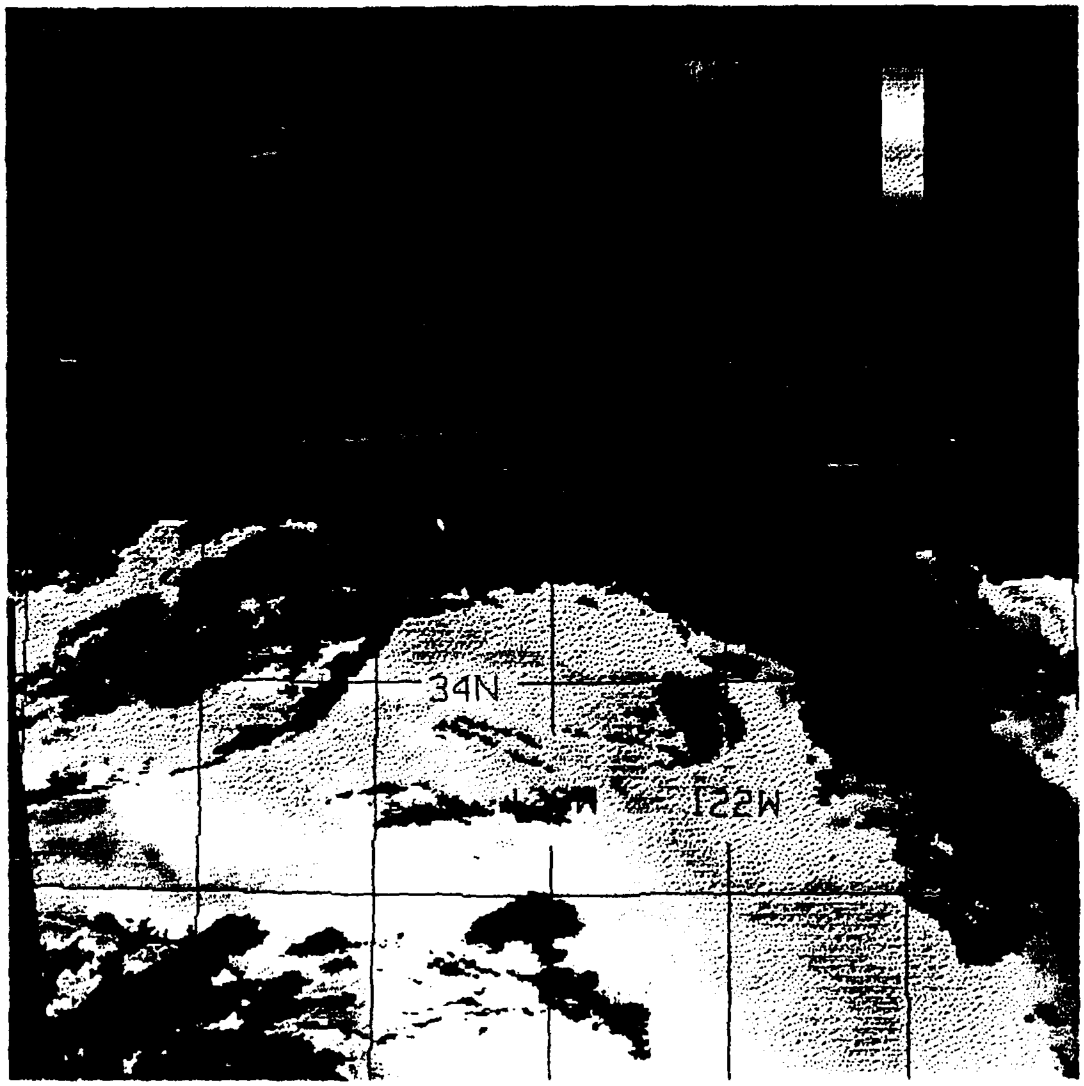
Picture #3



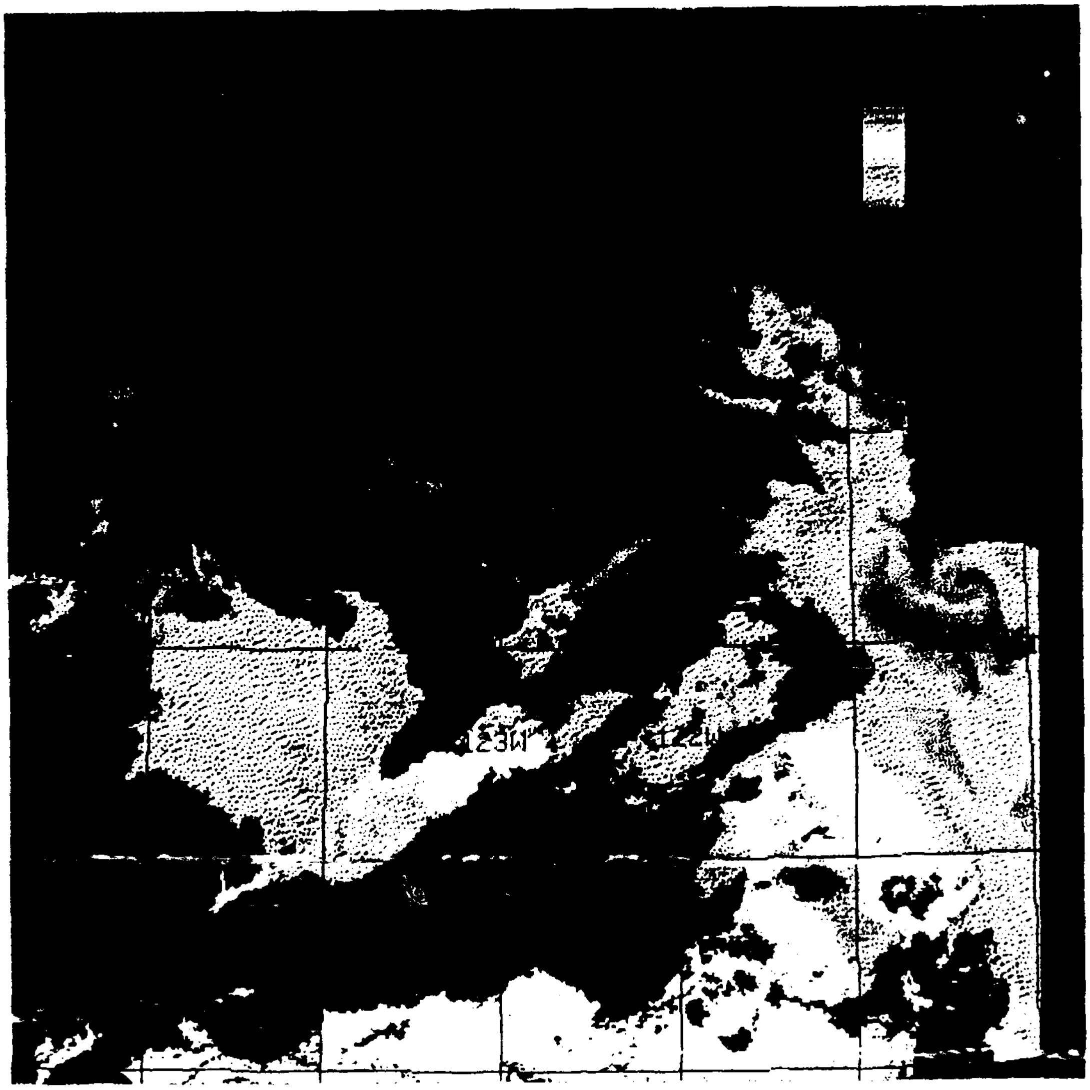
Picture #4



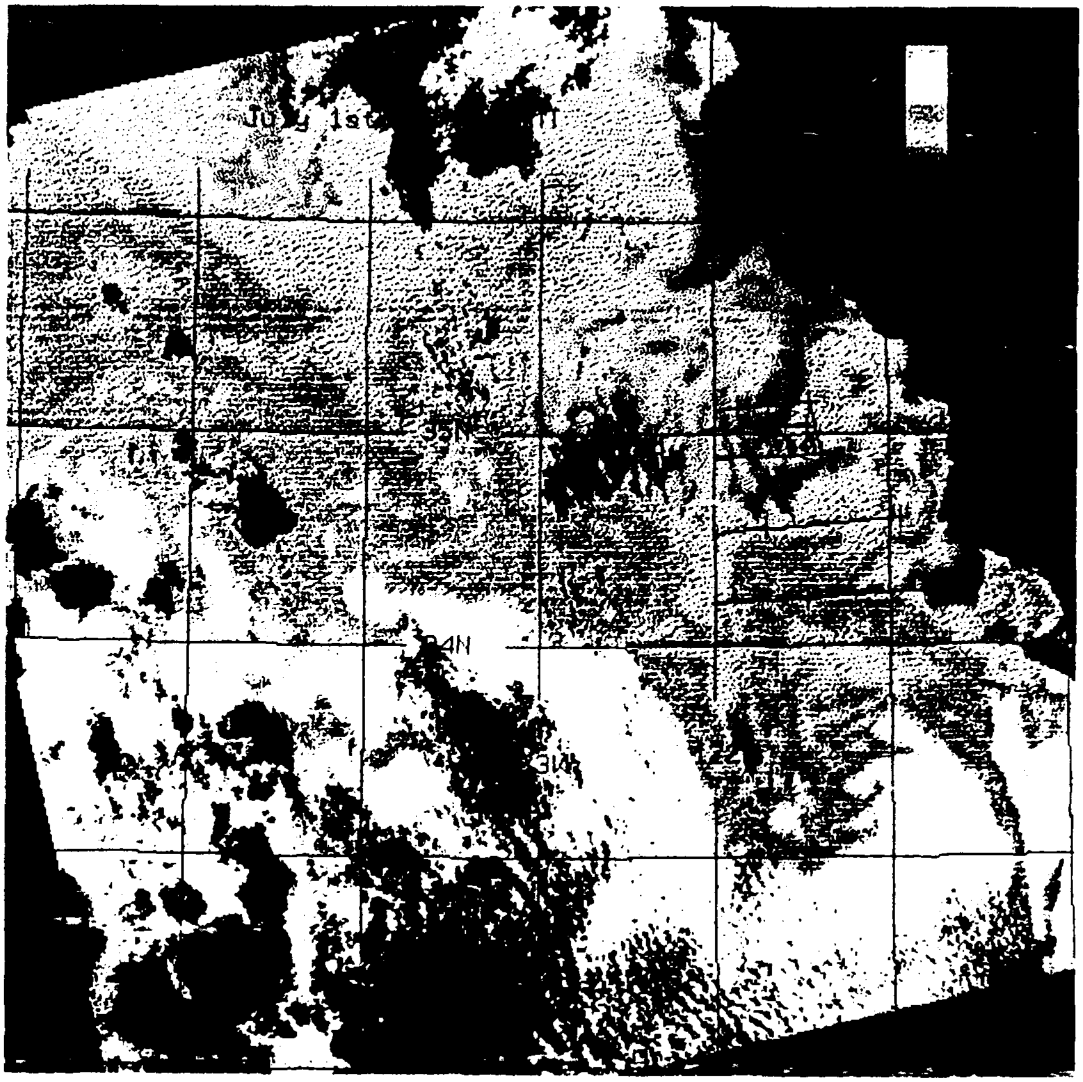
Picture #5



Picture #6

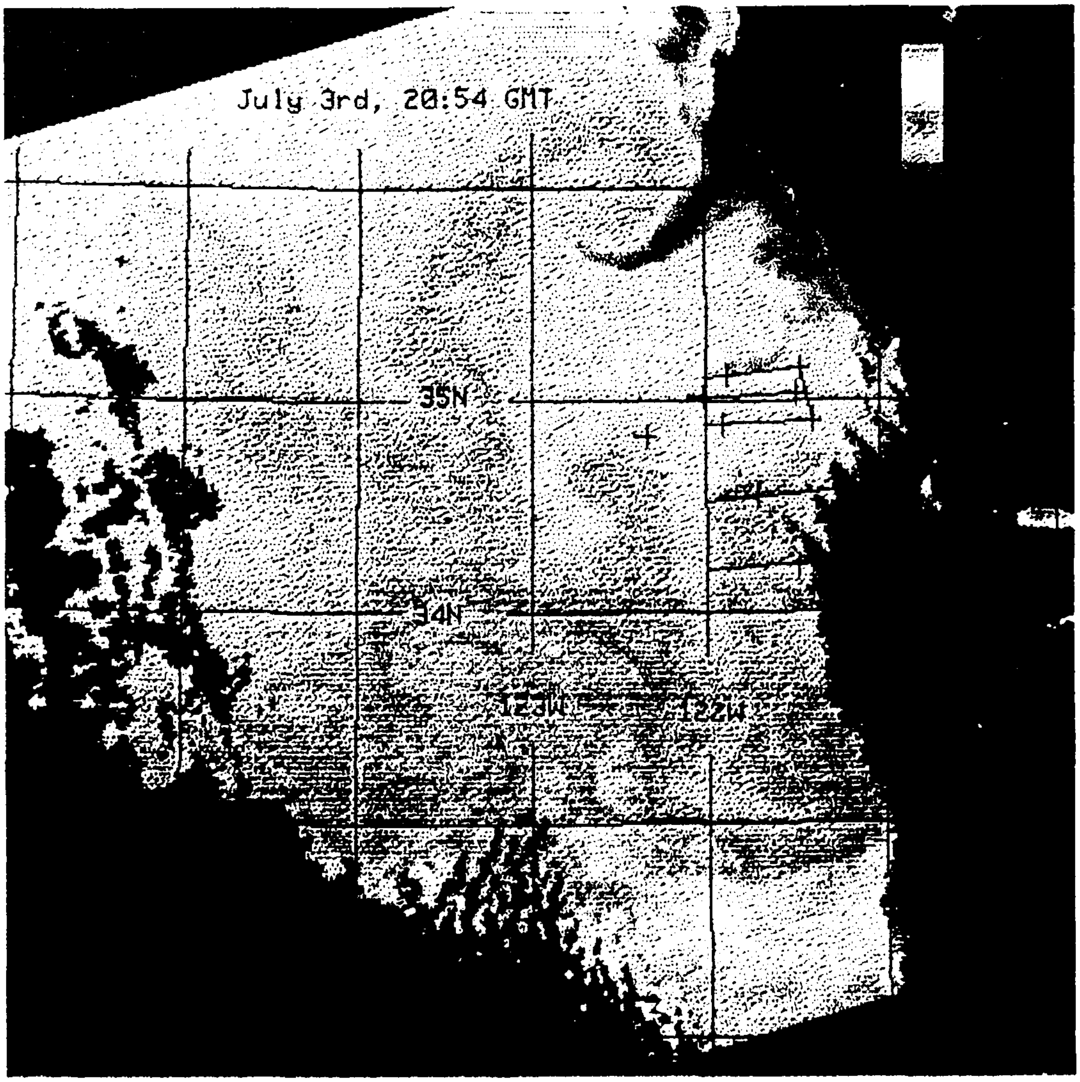


Picture #7

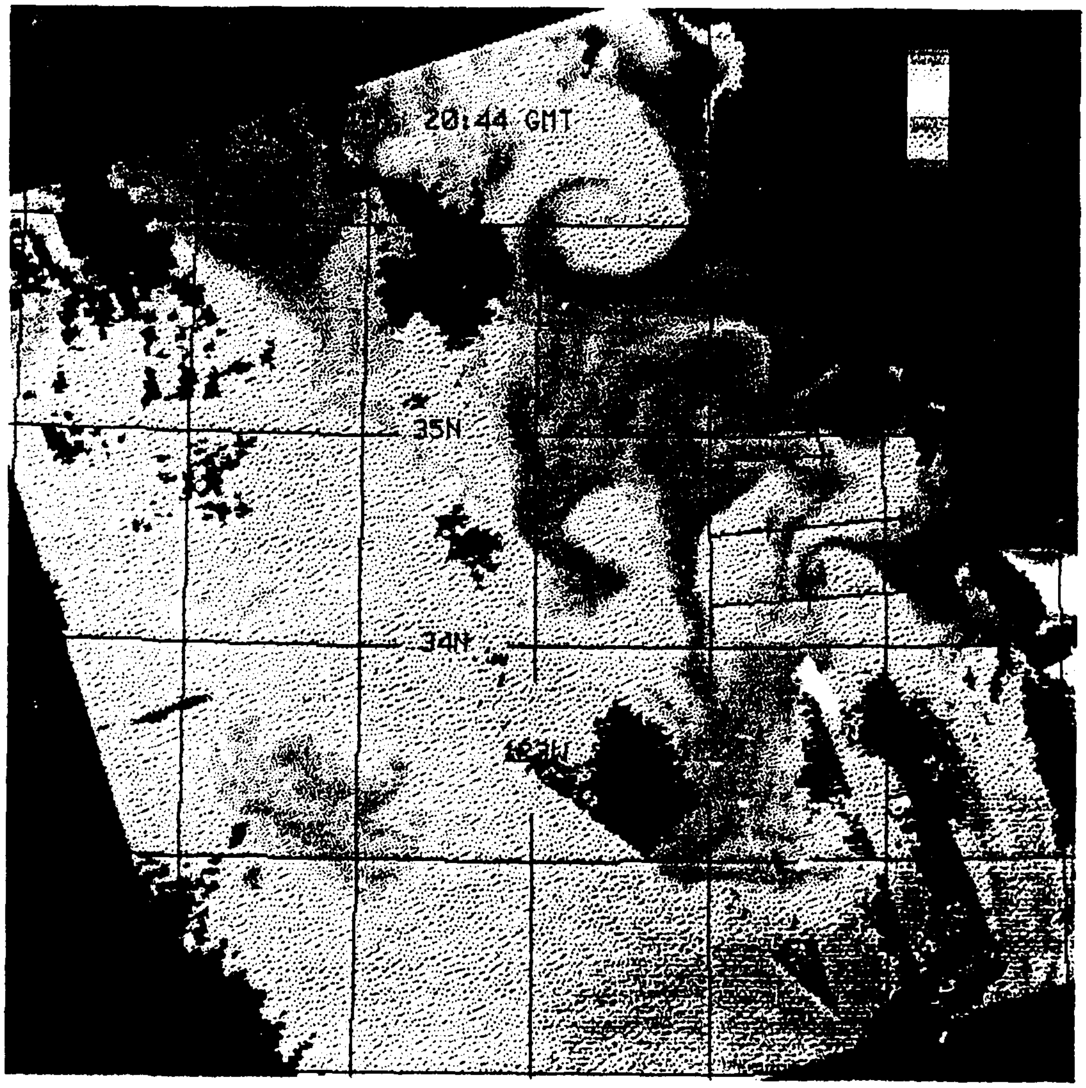


Picture #8

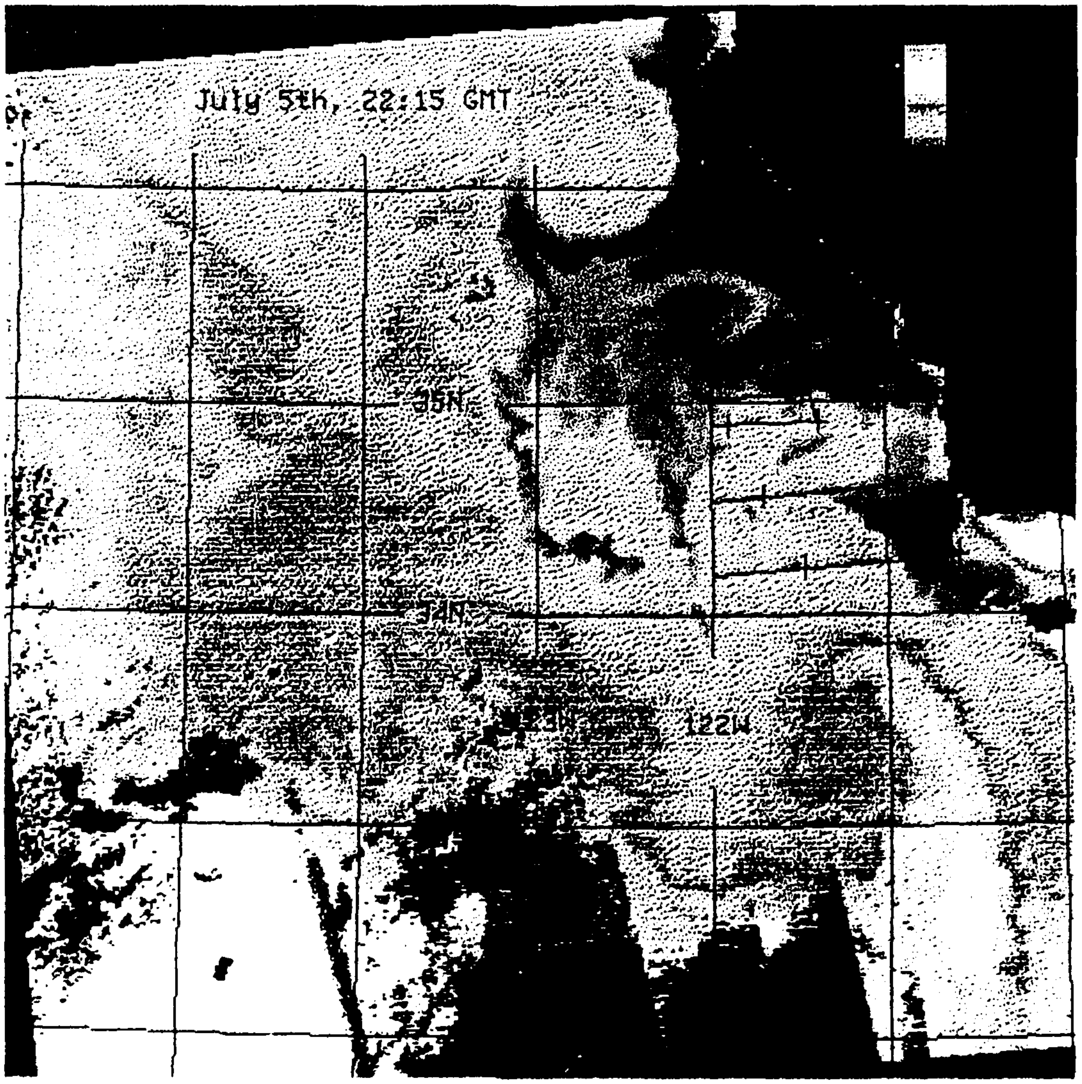
Picture #9



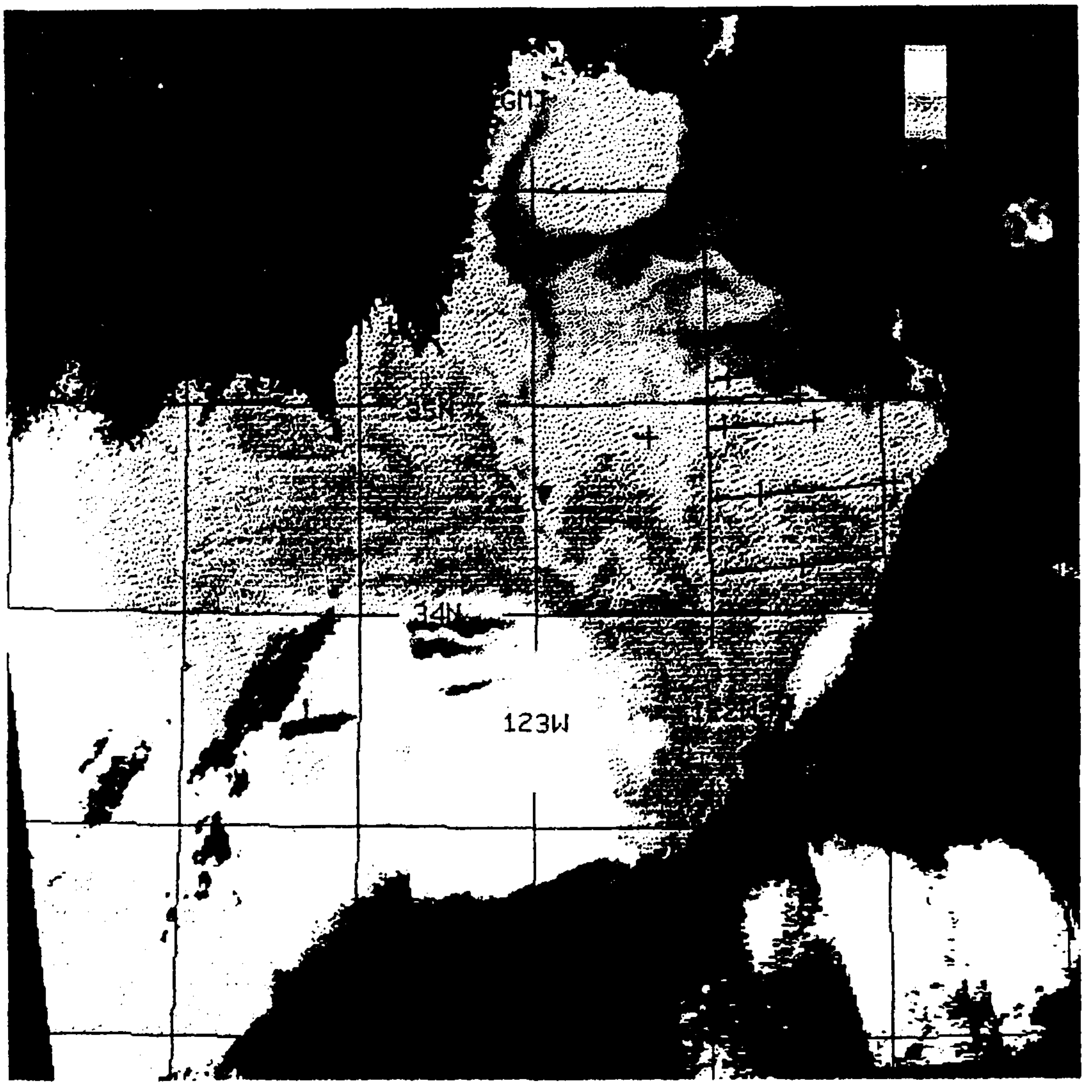
Picture #10



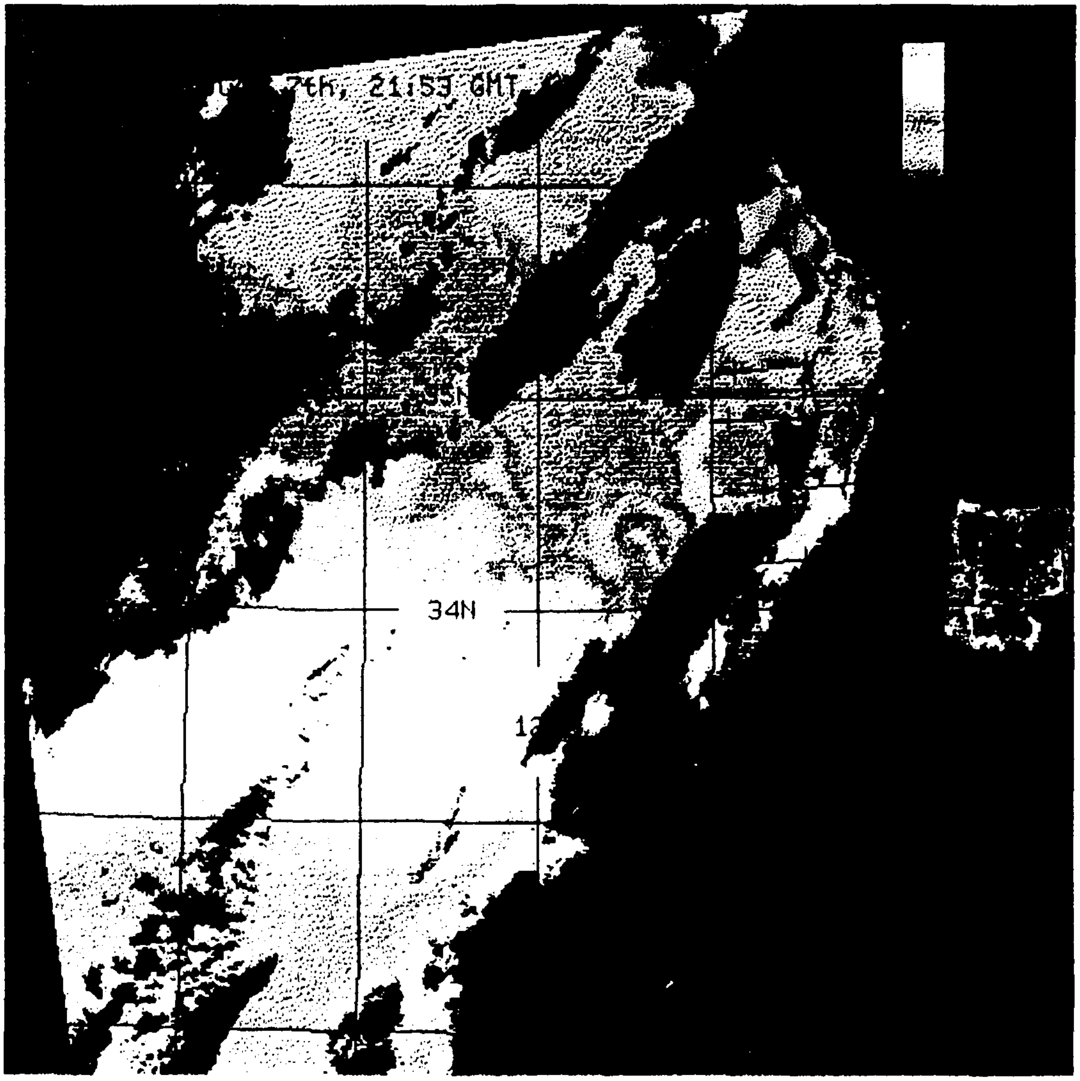
Picture #11



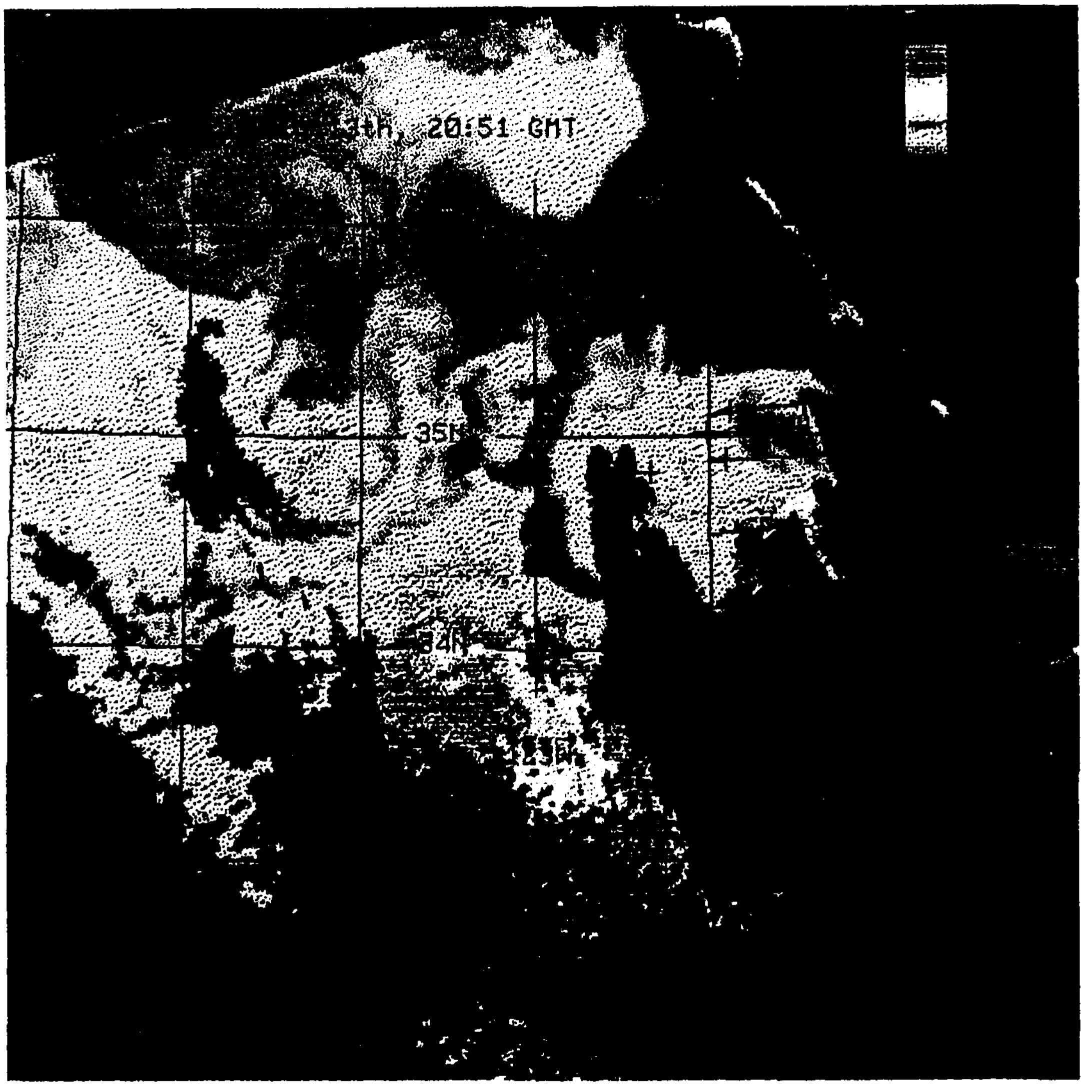
Picture #12



Picture #13



Picture #14



Picture #15